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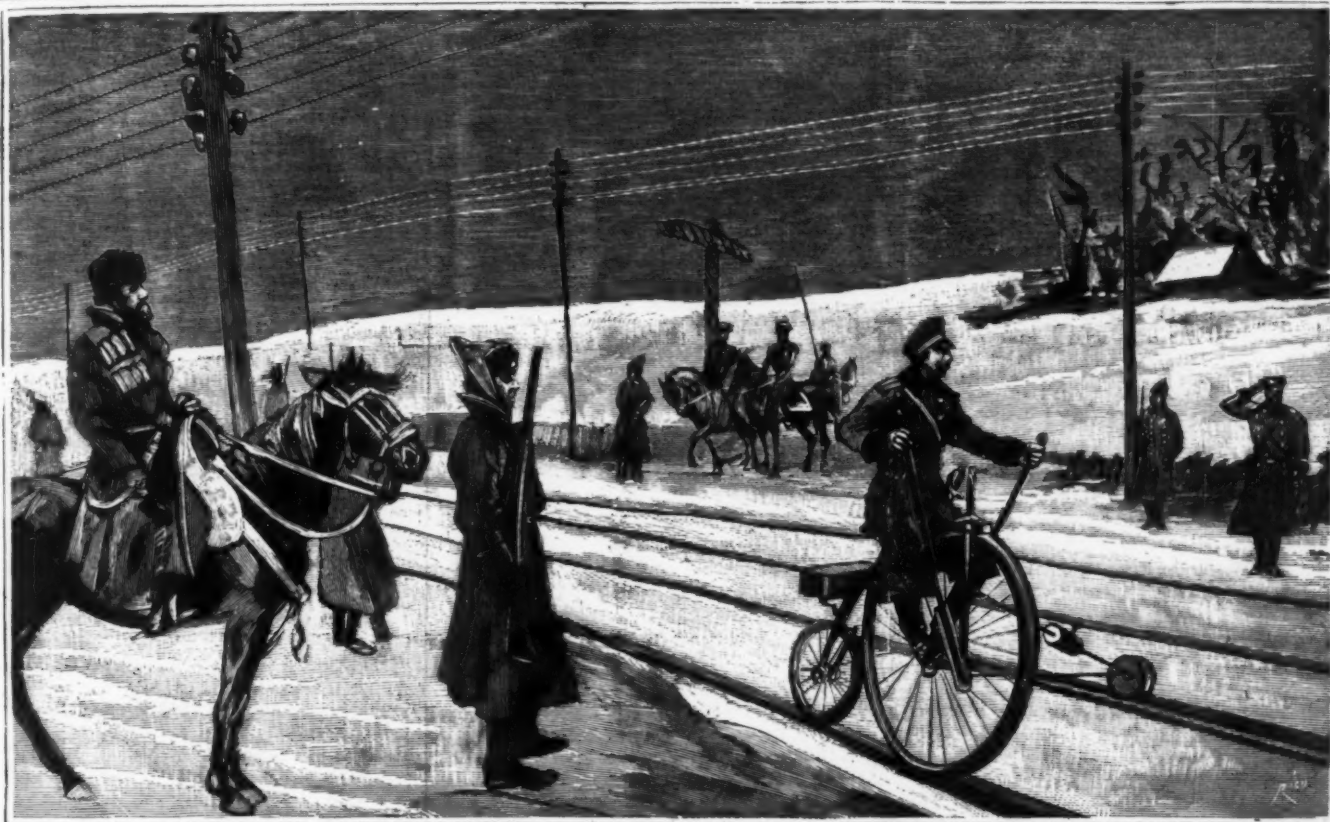
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RUSSIAN RAILWAY BICYCLE.



GENERAL VIEW OF MOSCOW, FROM THE KREMLIN.

RAILROAD PRECAUTIONS IN RUSSIA.

ON the occasion of the recent death of the Czar of Russia, his remains were transported from Livadia via Odessa, by rail to St. Petersburg, a distance of about 2,300 miles. As a precaution against accident and malicious dangers, a guard of soldiery occupied the entire line, the men being stationed within sight of each other. In addition, a corps of inspecting guards were made to traverse the road on bicycles constructed as shown in our engraving, with a lateral roller attached to an adjustable side arm.

MOSCOW.

Moscow, the second capital of the Russian empire, is situated on both banks of the Moskva River and is 400 miles from St. Petersburg. The present city measures seven by nine miles. The population of Moscow is about 700,000. In the center of the city on the left bank of the Moskva stands the Kremlin, in which many of the events of Russian history have transpired. The Kremlin is an old fort of pentagonal shape and the walls inclose 98 acres. The walls, which have been restored in the present century, have five gates and eighteen towers. Within the walls is a remarkable collection of palaces, churches, gardens, towers and monasteries. The Uspensky Cathedral is the most venerated of all the buildings in the Kremlin. The first church was built on this site in 1326. The present edifice has been restored several times. It contains a highly treasured religious picture attributed to St. Peter or St. Luke.

The cathedral is of great importance, as in it the

BALL BEARING AXLES AND RUBBER TIRES.*

I THINK it was Thomas Carlyle who said he was willing to listen to any man's convictions; "but," said he, "keep your doubts to your self; I have enough of my own." In talking on this subject I shall try to give you a few of my convictions and the reasons for them, and will keep my doubts, for it is clear that most of you have doubts of your own on the questions about which I am to talk.

There are but three reasons why we need horses or any other motive power with which to haul vehicles. These reasons are gravity, air resistance and friction. Air resistance must be taken into account at high speeds, but for ordinary traffic is not considered. Gravity is a constant factor whose influence cannot be lessened except by the grading and leveling of the road.

Friction, as considered in this case, is of two kinds. One is the rolling friction at the points of contact with the road, and may be lessened in two ways; either by improving the roads or the tires, and there is much need of improvement in both. The other is the sliding friction between the axle and inner surface of the wheel hub or box. It is proposed to substitute rolling friction, in the form of balls or rollers, for the sliding friction now commonly used.

Although the ball bearing has been known for many years, it was never used to any considerable extent until the advent of the modern bicycle. No other bearing is now used in bicycles, except in a few of the very cheapest boys' machines. This form of bearing, in its present state of perfection, as used in bicycles,

ference between the ball bearing and the plain sliding bearing, which depends upon oil for its existence and comfort.

There is an interesting fact in connection with this as to the reason why oil is greasy and pitch is not. It is due entirely to the shape of the globules which it contains. If you take small shot and rub it between the fingers, they roll upon each other easily. Take a material such as sand, and it does not roll easily. That is the difference between a substance that is greasy and one that is not. The oil is ball bearing, and that is what makes it run so satisfactorily.

I have not thought it necessary to remember the figures given in any of these ball bearing tests, as in most instances the conditions have been different from those under which the carriage builder would use the ball bearing. But I feel justified in saying that a very conservative and practical estimate of the difference would place it in favor of the ball bearing by more than two to one.

This, of course, does not mean that the ball bearing would enable a horse to haul double the load, although that would be the result if the wagon wheels and the track over which they run were perfectly true surfaces, the one exactly round and the other exactly flat and level. But on the very best roads, as we have them, the road friction is much more than the friction at the axle, and will be treated of in connection with the rubber tire.

The various forms of ball bearings will no doubt all be placed before you by those interested, and with ample illustrations and arguments. They are divided into two general classes, the one having a row of balls at either end and the other having the balls more or less distributed over the surface of the axle.

I think one of the most, perhaps the most, serious objections to the use of ball bearings on road vehicles is the fact that the average coachman, and even the average owner, does not fully understand the care of the axle which they now have, and which is the ideal, so far as simplicity is concerned.

When you are to add from twenty to one hundred and fifty parts to each wheel for that same coachman to look after, you may be pardoned if you proceed with extreme caution.

I would like to tell you of two instances occurring when we first introduced pneumatic trotting sulks. The first case was where the tire was partially unscrewed, enough so as to see some of the balls. The purchaser of the sulky did not know anything about the balls, and unscrewed it, and the balls dropped out into his hand. He looked at them very carefully and then said: "I wonder what fool has been putting shot in my bearing?" That was an actual occurrence.

The next instance was that of a horseman who had gotten a pneumatic sulky. He came back in the course of a week and had the tire on his arm. He threw it on the floor of the shop and said, "I paid my good stuff when I bought this and I want to know what you take me for?" "What is the matter?" he was asked. He replied, "The blamed thing is hollow." It was an interesting fact that that man didn't know that the tire was intended to be hollow; he had no notion of it.

The horsemen of to-day are beginning to be slightly educated in this subject. Now, the carriage maker is going to put these things on his vehicles, and he is beginning where they first began to put pneumatics on bicycles, and will have to go all over that same thing, too.

I think it entirely possible, however, even if it has not already been done, to make a bearing which will run for months, or possibly, a year, with but once oiling. In that case, the cleaning and reoiling could be attended to by an expert. But there is another problem which is not so easy, and this is to keep out the dirt and water, for that same coachman has a way of directing the hose at a bearing which is liable to be to its disadvantage.

Bearings having rollers instead of balls have been much talked of, and used to some extent. Theoretically, the roller bearing would seem to be more enduring than the ball bearing, but it is not adjustable. This may or may not be a disadvantage, for some ball bearings are in use which are not adjustable, and certainly all the old style bearings now used are not.

The most advantage would be gained by using these ball or roller bearings in the hubs of the heaviest trucks, and, so far as I know, nothing in that direction has been done. The horses which had almost nothing to haul in the first place are favored with the advantages which are to be gained by the use of ball bearings, and the overworked truck horse, like his human prototype, still plods on, and, unlike the workman, says nothing.

In summing up the points which I feel surest about in connection with the ball bearing for carriages, I would suggest, first, don't ignore it entirely, or, if you do, don't say much about it, for there is more than a possibility that it is coming to stay. Second, I would think it a wise thing for the progressive carriage or wagon builder, if he has not already done so, to get at least one set of the new bearings in use. But it is also well to see that they are used by a customer who really wants them, for the imagination of man is a wonderful thing; and whosoever buys a new fangled thing against his judgment is too apt to make use of it to prove his former theory.

Of all the shapes in which hardened steel is wanted, the ideal shape is the sphere. It will stand a higher temper with less danger from cracking than any other shape. Whatever the style of a ball bearing, the balls and parts with which they co-operate should be hard—for easy running and durability they cannot be too hard. But toughness must be combined with hardness to an extent that will render them safe against breaking. All parts of a ball bearing should be easily renewable without disturbing the axle or hub, and, so far as possible, bearings should be designed so that they would not suffer too much from the breaking of a ball or other hardened part.

The making of these balls is already brought to a high state of perfection, but you, who have to do with the hardening of steel, know that absolute immunity from flaws is not to be had; and in designing anything it is best to assume that it will go to pieces and need repairing sooner or later.

I am somewhat in doubt as to whether it is best to have a ring closed against the coachman and



RAILWAY MILEAGE OF THE WORLD.

Russian metropolitans and patriarchs were consecrated, as well as the czars after Ivan IV. The Arkhangelsk Cathedral was built in 1333, and the present edifice was constructed in 1505. It contains the tombs of the czars from Simeon (1353) to Ivan Alexeevitch, who died in 1696. Several other interesting churches are in the Kremlin. The Voznesensky Convent contains the tombs of the wives and sisters of the czars. The great tower of Ivan Veliky contains many bells and affords an impressive view of Moscow. Near this campanile, which is 328 feet high, is the largest bell in the world, the so-called Tsar-Kolokol (czar of bells), 60 feet in circumference, 19 feet high and weighing 192 tons. It was cast in 1735 and was broken during a fire two years afterward before it was ever rung. The Kremlin contains other objects of interest, such as the treasury of the patriarchs and the great palace of the emperors. Altogether, the Kremlin is one of the most peculiar places in the world and is a subject of never-ending curiosity to all visitors to Russia.

RAILWAY MILEAGE OF THE WORLD.

WITH a view of giving a detailed presentation the above graphic illustration has been prepared for the Railway Review, by Mr. C. C. McCain, auditor of the Interstate Commerce Commission. It will be seen that if to the mileage of the United States were added that of British North America, Mexico and Brazil, these four countries of the western hemisphere possess more than half of the entire mileage of the world.

was impossible until within a few years, owing to the difficulties in the way of making balls which are not only round but alike in size. You may now order a hundred thousand balls, say one-fourth inch in diameter, and in your order you may specify that you will not accept any ball which varies more than one-fourth of an inch from the diameter given. Any first-class maker of balls will accept the order and fill it, and still greater accuracy may be obtained at no considerable advance in price.

A ball bearing in which the balls are not alike is unsafe, for the reason that as the larger ball comes to the side which is sustaining the load, it must take almost the entire weight. This tends to wear both the balls and their track into bad shape, and is liable to cause a hasty and often unjust criticism of ball bearings in general. An average sheet of tissue paper is about 1/1000 of an inch thick. This seems like a small measurement, and yet a ball which was 1/1000 of an inch larger than its fellows should be condemned as entirely unfit to be placed in any bearing.

Whatever the outcome of the application of ball bearings to carriages, no success can be hoped for except through good material and workmanship. It is one of those cases where the height of extravagance will prove to be the most rigid economy.

Many tests have been made to show the relative power required to start and continue in motion bearings of different kinds, and especially to show the dif-

* Read before the Carriage Builders' National Convention, Philadelphia, October, 1894.—From the Hub.

teamster and have it attended to only by an expert, or whether it would be better to aim at a greater simplicity, and expect the drivers to take care of them, as they do now. The bicycle has done much to educate the average man in mechanical matters, and it is possible that he has more natural "gumption" than we give him credit for, which, being developed, may enable him to better appreciate the tools with which he works.

I believe it to be greatly to the advantage of the manufacturer to have his customer as familiar as possible with the details of the vehicle, and so I am inclined to believe that the successful ball bearing of the future is likely to be one which may be readily taken apart, cleaned, put together and adjusted by the more intelligent drivers. It is very important that all wearing and breakable parts of a ball bearing should be made on the interchangeable plan, and that duplicates be kept on hand by the repairer, if not by the driver.

If the ball bearing be once thoroughly introduced and become popular, people will submit to delays in repairing; but while the question is in doubt, those interested in the matter should adopt every possible means of meeting adverse criticism with practical results. Another drawback to the introduction of the ball bearing is the fact that the advantage comes mostly to the horse, and is not appreciated by the man until it shall be brought home to him in some practical fashion where the advantage will appear in the expense account, either in the oats consumed or the tons hauled. And here is one of the points in favor of the introduction of an elastic tire, which benefits the horse, as we can show, but the great advantage to the driver is apparent before he has ridden a minute.

The horse pulls the load that is hitched to him without complaint, but his owner, who is to determine the question of ways and means, sits on the load, becoming a part of it so far as the horse is concerned, and he says a great deal.

Fine spun theories count for very little with the average man, but when you can show him great additional comfort, you then have but two points to consider, viz., first cost and durability. And these I believe to be the only two things to be considered in connection with the elastic tire.

The old time wagon maker who had been used to making a felly of several pieces of wood tied together with thongs of rawhide found that the wear of the road soon cut off the rawhide, even at the speed at which things moved in those good old days. So he bored holes through the outer pieces of wood, and put his rawhide strings through these holes instead of having them go over the tread face of his wooden tire. And I have no doubt that the people of that day gave unstinted applause to the originator of this innovation. Finally, somebody discovered that bent iron segments could be nailed onto the wood, and this greatly increased the durability of the wheel, but the grandest step in advance was taken when it was found that an endless iron hoop could be shrunk on to a wheel, and the whole thing held firmly together as one piece. The descendants of the discoverer of this improvement may point out as a monument to the memory of their ancestor all the wheels in the world to-day. The endless metal tire which you all use has well served its purpose for 200 years, and like the plain axle bearing, it will be given up reluctantly, if at all.

One of its features, that of binding the wheel together, may always be a necessary part of the present style of wheel. But whether it is the best thing to come in contact with the road is a question which many are now engaged in trying to settle.

Properly made elastic tires cause the vehicle to haul easier and last longer, but the advantage which takes effect instantly, and which begins to pay dividends at the outset, is the soothing effect on the passengers.

I will say right in this connection that the pneumatic tire is not a new thing. It was made over forty-five years before there was such a thing known as a bicycle. It was applied to a carriage by a man named Thompson, of New England. It was not until forty-five years later that the pneumatic tire was applied to bicycles. In 1845, when Mr. Thompson thought to make a pneumatic tire for a carriage, it was considered an absurdity too great to be mentioned.

I will first consider the matter of draught or road friction, and give you the result of some tests which I have recently conducted, and which are now made public for the first time. Two box buggies were employed, one having the usual steel tired wheels, 44 and 48 inches in diameter, and weighing 254 pounds; the other having pneumatic tired wheels, 32 and 34 inches in diameter, and the vehicle weighed 232 pounds. The cross diameter of the tires was two inches. An amount of weight equal to the difference was placed in the lighter vehicle, and care was taken to see that the front wheels of the two vehicles bore exactly the same weight.

The surface upon which this first test was made was a new, hard pine floor, which was as smooth as such a floor could be, and the wheels were drawn lengthwise of the boards. The amount of power required to move these vehicles under the following conditions was carefully noted by means of a registering spring balance which was attached alternately to the king bolts by means of a long cord.

In each case several tests were made, and when all did not exactly agree, owing to slightly varying conditions at different points on the tire, we took the average pull.

The same tests were made with the vehicles empty, and afterward when they were loaded with 300 pounds each. It was found that the power required to start the pneumatic tires from a standstill was four pounds, and the power required to haul them at a slow walk was three and a half to four pounds.

The power required to start steel tires was found to average but three pounds, and when started, the power required to draw them was but one and a half to two pounds, showing an average difference of about fifty per cent. in favor of the steel tires.

Next, an obstruction 5-16 of an inch high was placed in front of and against the wheels of each vehicle. To haul them over this obstruction from a standstill required, in the case of the steel tires, 25 pounds; with the rubber tires, but 11 pounds. Then they were drawn at a slow walk over the 5-16 inch obstruction, and it was found that the power required to draw the rubber tires was 5 pounds, and the steel tires 8 pounds.

It should be remembered that the steel tired front wheels under which the obstructions were placed were 13 inches larger in diameter than were the rubber tired ones, and it is a well established fact in mechanics that a large wheel will go over an obstruction with a less expenditure of force than will a small one.

When the first pneumatic sulky, with its 28 inch wheels, began to lower the trotting records, thousands of horsemen and mechanics at once began to reason that if there was such advantage in the pneumatic tire as to make the little wheels win, what couldn't be done if the same tire were placed on a large wheel?

For obvious reasons we shall never know how many experiments were tried, but enough of them have come to light to prove that the 28-inch wheels, which are universally used to-day, were not accepted blindly.

The question has been repeatedly asked, Are not large wheels better than small ones, and if so, how do you account for the present revolution in trotting gigs?

My answer is that large wheels are certainly better than small ones in theory, and within certain limits they are better in practice.

A pneumatic tire is better than a steel tire, for reasons which I will shortly explain, but it is comparatively heavy and has required a flanged metal tire under it which will weigh fully as much per running foot as would a standard steel tire for the same vehicle. And, besides, the smaller a pneumatic tire is, the more practical it is to make and maintain.

The pneumatic tire is an advantage. The small wheel is a disadvantage, or at least, it has been found so when used with a hard tire. From the advantages of the one, we subtract the disadvantages of the other, and find that we have a balance in favor of that combination, which warrants and has accomplished its universal adoption, viz., 28-inch wheels and 1 3/4 inch tires.

To return to the tests: An obstruction seven-eighths of an inch high was placed against the wheels, and the power required to haul over it from a standstill was as follows: Rubber tires, 24 pounds; steel tires, 44 pounds. At a walking speed the power required to go over the seven-eighths inch obstruction was 16 pounds for the steel tire, and 12 pounds for the rubber tire.

The two carriages were next loaded with 300 pounds each. It was then found that the power required to start the rubber tires on the smooth floor was 8 pounds, and to haul at a slow walk required practically the same force. To start the steel tires, loaded, required 12 pounds, and to haul at a walk, 4 pounds. The 5-16 inch obstruction was then placed in front of the wheels, and the power required to haul over it was 13 1/2 pounds for the rubber and 40 pounds for the steel tires.

Over the 3/4 inch obstruction the power required to haul the two loaded carriages was 36 pounds for the rubber and 69 pounds for the steel.

The two vehicles were then taken out of doors, and placed on a fairly good gravel road.

The power required to haul the rubber tired vehicle, loaded, 300 pounds, averaged 20 pounds, and the extreme power required at any point was 26 pounds. With the steel tired vehicle, over the same road, the average was 41 pounds, and the extreme 79, or three times the resistance of the rubber.

To haul these two carriages empty over a moderately sandy road, the extreme power required for the rubber was 26 pounds, the same as when loaded on gravel with an average of 16. The steel tire vehicle required an extreme of 40 pounds and an average of 22.

With a load of 150 pounds, the steel tire required an extreme of 57 and an average of 40; and the rubber, an extreme of 38 and an average of 16.

After these tests had been made over this particular piece of road, the rubber tired vehicle was again tried empty, and it was found that the hauling of it six times over the road had so improved that, instead of the extreme pull of 26 pounds, and an average of 16, the extreme was but 16, with an average of 8.

If we had a perfectly true surface for a road, and perfectly true metal wheels, nothing better could be desired; but the words "perfectly true" mean, in the case of the roads, an impossibility. Even the surface of the best race track is made up of small obstructions.

We have in Waltham, Mass., a bicycle track which is made of cement or granolithic. To stand and look at it, it seems to be perfect. I have thought that on a perfect surface a pneumatic tire would be a disadvantage, so I suggested to a bicycle concern that a machine be made with solid tires, that is, a narrow wooden rim, and then a coating of rubber an eighth of an inch in thickness. It was made and sent to me, and when I tried it I was perfectly thunderstruck to find the track was nowhere near perfectly smooth. There is no perfect road; there never has been a perfect road. Even the asphalt we have on Broad street is full of little obstructions when you come to run over it with a tire not yielding.

If the metal shod wheel meets a gravel stone quarter of an inch in diameter, and that stone is resting on a hard foundation, the wheel, with its entire load, must be lifted bodily a quarter of an inch high to pass over it, and this takes horse power; but when the rubber tire meets the stone, the vehicle is not raised perceptibly, if at all, but the stone is embedded in the rubber, while most of the weight is borne by that part of the rubber which is still resting on the ground; and the power required to go over it is only that needed to dent the rubber in one spot, or, if it is a pneumatic tire, to slightly compress the body of air which it contains.

There are four reasons why a pneumatic trotting sulky is faster than the old style; and every one of these reasons applies with more or less force to an elastic tire of any kind for any vehicle:

First. It draws more easily.

Second. Owing to the small diameter of the wheel, the sulky is much stiffer sidewise and the soft tire stays on the ground and does not slew in rounding curves.

Third. When a horse is being crowded to his utmost limit, as all horses are supposed to be in a race, his

nerves are under an intense strain, and he is kept near the point where he will no longer hold to the unnatural motion of trotting, but will adopt the run, which comes perfectly natural to all four-footed animals. The noise and jar of any hard tired vehicle when going at speed has much to do with the action of any horse.

Fourth. The more securely and comfortably any driver is seated, the better attention he can give to the trotter, and a nervous driver tends to make a nervous horse.

Elastic tires are at present of two kinds. One depends upon the yielding nature of a mass of rubber and the other uses compressed air, rubber being employed only to render the confining fabric air tight. For racing purposes, where extreme speed is required, that tire will be fastest which has the least between the compressed air and the ground, as compressed air is much more elastic than rubber; but as the ideal tire would not be practical, owing to the danger of bursting and puncture, it is necessary to compromise on a quality and thickness which may combine as much as possible of the air spring with the important element of durability. Pneumatic tires are made and used on vehicles which give no trouble, and I know of two four-wheeled carriages which have run on pneumatic tires every day since last spring without the necessity of pumping the tires once during the time. I have known solid rubber tires to run over a year without trouble. If speed is wanted, the pneumatic tire only is to be considered, for some reasons that I will explain briefly to you with a bicycle wheel. (Here Mr. Elliott illustrated the resiliency of the pneumatic tire by producing one on the stage and accompanying his remarks with illustrations of its action when in use.)

For ordinary road driving, however, the solid rubber tire has advantages which may, for certain vehicles, offset its lack of resiliency. Neither tire, as made to-day, is as durable and safe as we might wish. Both require more care and attention than the old metal tire, and it is not probable that any elastic tire can ever be made which will compare with the other for all around results on all sorts of roads, and in the hands of ignorant men.

It is undoubtedly true that an inferior vehicle with elastic tires will outlast the best one made which has metal tires, and by the same reasoning any vehicle will last much longer with than without the rubber.

And many intelligent men claim that enough will be saved in repairs and gained in the extended life of the carriage to warrant the expense of new rubbers each year.

If that should turn out to be true, the question is settled, for rubber tires which will last more than a year are now obtainable.

The item of comfort to the passengers is the most remarkable, and this is obviously the strongest point in favor of the rubber. In fact, the difference is so great that to many people the questions of cost and durability do not cut any figure. A person with nerves who has ridden much on elastic tires is never quite as well satisfied with hard tires afterward. Another point which is greatly in favor of the soft tire, and which is important, if anything is, it not only does not inflict injury upon the road, but is a positive benefit to it, for the reason that while the metal tire, in the direction of its length, is round and touches the ground hardest at a single point, the soft tire lies perfectly flat upon the road for several inches and does not tend to press any part of the loose surface out of place, but does act to constantly press it more firmly together.

I have noticed where a large number of bicyclers have passed any common point on a muddy road they naturally look for the best place. I have seen a path a foot or two in width, that looked perfectly dry, while the mud showed water on each side, caused by the continual passing of the tires, which had passed over it and smoothed it.

The signs of the times, as they look to me, are, that there will at no distant day be a considerable demand for pleasure vehicles fitted with elastic tires. The thicker and more elastic the tires, the smaller may be the wheels down to, say, thirty inches. Many intelligent carriage users are beginning to save up their money to buy a set of rubber shod wheels, and I believe that the carriage builder who keeps his fingers on the public pulse, and is in a position to know what is up to date on these matters, will find, when the inevitable demand comes, that he is several lengths ahead of the builder who sneers at the new tire, and tries to talk the progressive customer into taking something else.

But there is by far a larger and wider field which seems hardly thought of at present.

I feel safe in predicting that the time will come when the intelligent truckman, the teamster and the expressman may reap direct financial benefit from the use of elastic tires. The poorer the man is, and the harder he has to work to make a living, the more reason there will be for his adoption of the highest quality of elastic tires.

It is entirely consistent with the facts to say that the intelligent application of the latest wisdom in tires and bearings will enable one horse to haul a larger load than can be hauled by two horses on the best wagon as at present made.

This is surely enough again to revolutionize wagon building, even though there were no other advantages. But we must put on the other side of the ledger the items of first cost, risk of damage, additional attention, and cost of renewals. What the balance will be no man at this date can tell you. But the problem is by no means as difficult as are many which have been successfully solved.

MANUFACTURE OF CHEAP WATCHES.

THE recent excursion of the American Institute of Mining Engineers and their visit to the Waterbury Watch Company's works at Waterbury, Conn., is described by a correspondent of Engineering as follows:

On March 3, 1890, the plant was purchased from the Benedict & Burnham Manufacturing Company, and the Waterbury Watch Company was organized with a capital of \$400,000.

The factory is one of the finest in the country, using the most modern automatic machinery, and employ-

ing a high class of skilled operatives. From an architectural point of view the building is remarkably beautiful. It is trimmed in front and at all sides by a fine growth of Ampelopsis Vetchii, and spacious lawns, answering the practical purpose of avoiding annoyance and trouble from dust, set the building off to advantage.

The first Waterbury watches were put on the market during the autumn of 1879. Previous to this time there was nothing between the cheap toy watch at 25 cents and the poor Swiss watch selling at \$15. It remained for the Waterbury Watch Company to place within the reach of the masses the only luxury they lacked to make them equal in possession to their wealthiest companions—a watch. The Waterbury watch was from the start a success. It at once took its place in the market as a favorite, and since that time the strides of improvement in the models and styles have been rapid and continuous. The watch as originally made had only 54 parts, less than half the number required for any other type of watch. It was a radical departure from conventional ideas in watch making, a peculiar feature being the rotation of the works within the case once in 24 hours. This required a long thin mainspring, 9 feet in length.

The manufacture of the long wind watch was discontinued several years ago. Now it is quite remodeled, comprising many different sizes and styles, with nickel, silver, and gold cases, the rotary motion of movement and the long spring being no longer a

18, 14, 10, 8, 6, and 4 sizes; and this season a new watch, the "Elfin," which is the smallest watch ever made in America, has been put on the market. It is about the size of a shilling. Other movements popular the world over are the Charles Benedict, the Tuxedo, Rugby, Oxford, Waterbury, Addison, Combian, etc.

In conducting business in the United States, a wise policy of the company has been the restriction of sales to the retail watch trade. This plan, firmly maintained for six years, has met such favor that there is hardly one of the 22,000 dealers in the new world that does not keep the modern Waterbury watch in stock. The company has its agents in all civilized countries, including London, Paris, Sydney, Melbourne, Bombay, Shanghai, Tokio, and throughout Central and South America. The prices vary from almost any price, dependent on art finish, down to \$4. The company also make a watch for blind persons, having raised numerals on the case, and points at every third figure, to enable them to locate the hour without difficulty. Naturally we at once descended to the engine room, and examined the Corliss engine. From there we passed to the adjacent machine shop. The very delicate machinery used in the manufacture of watches naturally requires the most constant care, and gives employment, as may be seen, to quite a number of machinists.

Ascending the staircase, we found ourselves in the cloak and wash room. This is most conveniently arranged, for the company evidently believe that cleanliness is next to godliness, and, moreover, are desirous their operatives shall present a most attractive appearance to the outside world as they leave the works. It may be said this was particularly true of the young women. Nowhere does any one meet a more intelligent class of people than is to be found among the young women in a New England factory. As a rule, they receive an excellent education, and certainly the faces of those in the Waterbury Company compared favorably with any your correspondent has seen in similar places. On questioning them, you found at once that they understood fully the construction of the machine they were tending. It was not a simple humdrum piece of work which they were performing, but they brought to their task an intelligent mechanical skill. The train department was next visited; the room was very light and well ventilated, besides being scrupulously clean. We next passed to the spring department, where the highly tempered springs are neatly coiled into place. The old spring in the earlier watches was, as said above, 9 ft. long, and it was currently reported the company intended to furnish each purchaser with a $\frac{1}{2}$ horse power engine to wind the watch at night; but now that the spring has been shortened, the present Waterbury watch is wound like any other. The case department was extremely interesting, and, as may be supposed, employs a number of operatives, each one doing some little thing to a case, which then passes to the next, for the variety of patterns is very great.

Finally, the various parts are assembled in the finishing department, and after inspection of a critical nature and testing, are put into the case. Any small variation causes rejection. It now remains to regulate the watch, and it then becomes a commercial article. When it is considered how minute some of the parts are, it will be seen how great a care is exercised to produce a perfect watch. As an illustration, the writer saw certain screws being threaded and a slot cut in the head. The screws were so small as to require a magnifying glass to detect that they were anything more than a tiny speck of metal. In the diagram on this page the various machine-made parts are shown, and so accurately are they finished, that any part may be ordered by number, and guaranteed to fit.

The following paragraphs describe the special features of the Waterbury watch. The first specialty lies in the adjustment of the escapement. "When the balance is at rest on a straight line from the center of the balance staff to the escape wheel center, the impulse pallet face should be 30 deg. from the slot in the balance staff. The balance moves 35 deg., when the long tooth drops into the slot, and 55 deg., when the long tooth leaves the slot, and the impulse strikes the short tooth. The hair spring should be set so that the long tooth of the escape wheel rests on the staff just back of the slot, so that a movement of 35 deg. in the larger movements and 25 deg. motion in a smaller movement is required to allow the long tooth to drop in the slot."

"2. The escape wheel, acting directly on the balance wheel, requires less power than a lever escapement; consequently, lighter mainsprings are used, and these are very highly tempered to allow of a more equal distribution of power than with a heavy spring. Having nothing but a balance and escape wheel acting directly together for adjustment obviates many difficulties that are encountered in the lever escapement, which requires the greatest accuracy to produce proper results."

"3. The duplex has not the same liability to wear as the lever, for the reason that such light power is required. The friction is so lessened that by actual test no wear is discernible on an escape tooth after six years of constant service. The life of a duplex is as long as that of any jeweled escapement."

"4. The duplex will run much longer, without cleaning, than a lever. The oil on a lever escapement soon becomes heavy, and the result is a dropping off in motion and poor time, while the parts in a duplex that require oil for action are so few that the thickening of the oil is not shown by any action of the movement. In cleaning a lever escapement the greatest care must be taken not to loosen either pallet stones or roller pin. These are held in place by shellac, and if they are loosened, trouble is at hand. With the duplex, there are no parts to get out of order, and should any become broken, they can be replaced without fitting."

"The differences in construction between the Waterbury movements and lever movements are many. No center wheel is used, and this allows a different construction of the dial train and a different fitting. No cannon pinion is employed; consequently, the hands need not be removed when the dial is taken off. Friction is greatly reduced by this method, the barrel acting directly on the second wheel with small pivots. In the dial train there is inappreciable friction, and in repairing no special operation, like fitting the cannon pinion to the center pinion staff, is required."

"The winding mechanism combines much simplicity and strength, and works with smoothness and accuracy; the winding attachment is composed of five pieces only."

The hands are set by pushing in the crum, and turning either way. All the jewels are held by a double plate and caps, and no small jewel screws are used. For balance and stone jewels there is an end stone screw in the lower plate, and in the end of this screw is set the end stone. As the screw has a fine thread, the adjustment for end shake is perfect, and can be made after the movement is together. It remains to add that the capacity of this factory is 1,700 watches a day.

A NEW DRAWING APPARATUS.

THE annexed engraving illustrates a new drawing apparatus called the Dikatopter by the inventor,



FIG. 1.—THE DIKATOPTER.

Heinrich Eppers, of Brunswick, Germany, and manufactured by G. J. Papst, of Nuremberg, Germany, and Rudolf Schwarz, of Vienna, Austria.

The dikatopter consists principally of a wooden box or base formed on its top with transverse black guiding lines and serving to hold the paper on which the drawing is to be made. At one side of the base is arranged a pivoted upright carrying two folding arms, one of which supports a copy holder provided with black lines similar to the base, and on the other is fastened a spring wire carrying the camera. The construction of the latter is illustrated in Fig. 2, and consists of a tin box containing the mirrors, x and y,

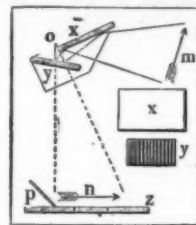


FIG. 2.—ARRANGEMENT OF CAMERA.

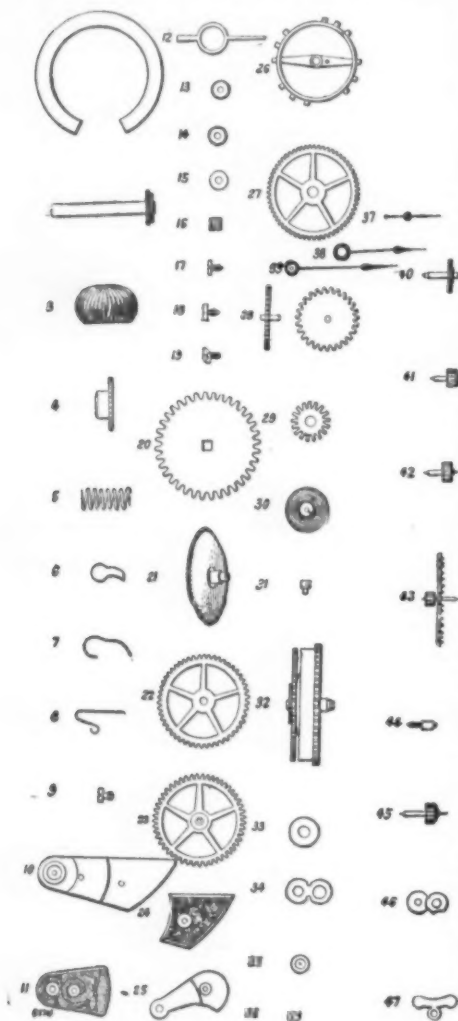
which are slightly inclined and shifted over one another. The silvered surfaces of the mirrors are polished, so that the metal surface is reflecting, and consequently the light does not need to penetrate a glass prism, as is the case in such apparatus as now constructed. The loss of light is reduced to a minimum, and, according to the inventor, only amounts to about 8 per cent., so that fully 92 per cent. of the incoming light is utilized.

The construction of the camera is easily seen in Fig. 2, in which m represents the object to be drawn by the pencil, p, at n, on the paper placed on top of the base, z. The rays of light from the object, m, pass upon the upper mirror, x, which reflects the rays onto



FIG. 3.—USE OF APPARATUS FOR COPYING PURPOSES.

the mirror, y, which throws the rays upward to unite at the point, o, at the eye of the observer, thus enabling the latter to see the object, which latter appears to lie at n, at the base, z. In order to make the operator's pencil, p, visible to the eye, the silvered portion of the second mirror, y, is formed with parallel silvered bars and intermediate black spaces, as shown in the separate plan view of the mirror, y, in Fig. 2. Now it is evident that by approximate equal illumination of the object, m, and the paper at z, both are



MACHINE MADE PARTS OF A WATERBURY WATCH.

1. Bow.
2. Winding arbor with setting pin.
3. Crown.
4. Winding pinion.
5. Push spring.
6. Click.
7. Click spring.
8. Winding wheel click spring.
9. Winding wheel click spring screw.
10. Balance bridge.
11. Balance bridge upper cap.
12. Regulator.
13. Upper balance hole jewel, set.
14. Cap jewel, set.
15. Lower balance hole jewel, set.
16. End stone screw.
17. Plate screw.
18. Plate screw, gray.
19. Case screw.
20. Hatched wheel.
21. Hour wheel.
22. Second wheel.
23. Third wheel.
24. Balance bridge lower cap.
25. Escape bridge.
26. Balance wheel.
27. Fourth wheel.
28. Winding wheel.
29. Setting wheel.
30. Hair spring and collet.
31. Hair spring stud.
32. Barrel and arbor.
33. Winding arbor washer.
34. Balance potence with end stone screw.
35. Escape jewel, lower, set.
36. Pallet.
37. Second hand.
38. Hour hand.
39. Minute hand.
40. Cannon pinion.
41. Second wheel pinion.
42. Third wheel pinion.
43. Escape wheel and pinion.
44. Balance staff.
45. Fourth wheel pinion.
46. Setting wheel potence, with stud.
47. Click cap.

feature of the watches made by this company. The duplex escapement is used in the Waterbury watches, and a very small thin mainspring is now used for the watches. Obviously this is a great advantage. The Waterbury Company is the only one in America making movements and cases complete. From 500 to 800 skilled hands are employed. The employment of trained expert help at high wages is one secret of the success of the company. Many of the hands have been with the company since its organization. All of the standard sizes are included in the remodeled types—

simplicity and accuracy of five pieces and turn a double screw crew is set thread, the can be made to add the day.

US. drawing inventor,

seen with equal distinctness, as the mirror, y, permits but one-half of the light of the object and the paper to pass to the eye of the observer.

Fig. 3 illustrates the use of the apparatus for reproducing a copy, it being understood that the black guiding lines on the holder and base permit the user to obtain the proper relation of the size of the object relative to the figure projected upon the paper, to prevent a distorted reproduction.

In copying a landscape or other large and distant object, the apparatus is arranged as shown in Fig. 4 and mounted on a suitable tripod. The copy carrier is removed and the camera mirrors reflect the land-

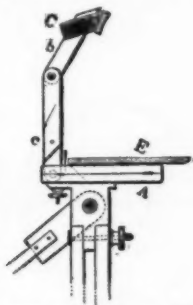


FIG. 4.—USE OF APPARATUS FOR DRAWING LANDSCAPES.

scape on a reduced scale on the paper, owing to the use of a concave lens clamped in front of the camera. In order to reproduce an enlargement of an object, a convex lens is used instead of a concave one.

It is claimed for this apparatus that it will greatly facilitate copying of drawings, objects, etc., and will lead beginners to drawing correct perspective views.

THE YARYAN EVAPORATOR FOR THE DISTILLATION OF SEA WATER UPON LAND.

THROUGH its mode of evaporating water in rapid and continuous motion, combined with the principle of multiple action, reaching a sextuple or greater action, the Yaryan apparatus permits, through the evaporation of sea or other water, of obtaining distilled water at a cost that renders it available for the supply of cities or districts deprived of potable water. The net cost naturally varies according to the price of the coal used. However, as in a sextuple acting apparatus it requires at a maximum but 65 lb. of coal to produce 2,300 lb. of distilled water, we can, even under the most unfavorable conditions, reduce the net cost to a low figure.

Our engraving represents a sextuple acting Yaryan apparatus which is operating upon the island of Perim, in the Red Sea, where it is producing 60 tons of distilled water a day. The generator is not here figured.

The apparatus consists of six horizontal evaporating cylinders that are here partially concealed by the column formed by the six separators in front. Upon the right, we observe three horizontal cylinders that constitute the surface condenser for the steam of the last effect and a chest for heating the sea water. Upon the same foundation are established the auxiliary feed and suction pumps.

In each element we find the same arrangements that exist in the evaporator for ships. The only difference consists in the situation of the separator, which, instead of prolonging the chest, is placed at the side, thus permitting of more ready access to the tubes. A hinged door provided with four nuts uncovers the plates and the return cells. The circulation

of the water proceeds from top to bottom. The upper cylinder constitutes the first effect, and is the only one that directly receives the steam. The water condensed in the first cylinder returns directly to the boiler, so that the latter has no need of being supplied with sea water.

The following are the results of the official trials made with the Yaryan apparatus for the production of potable water by means of sea water:

Place at which the apparatus is operating.	Perim (Red Sea).	Kosseir (Red Sea).	Troon (Scotland).
Production of water guaranteed per 24 hours.	40 tons	35 tons	50 tons
Water obtained per 24 hours.	61.3 tons	31.3 tons	63 tons
Duration of trials.	56 hours	24 hours	12 hours
Production of water guaranteed per unit of coal burned.	32 tons	32 tons	36 tons
Water obtained per unit of coal burned.	35.7 tons	33.9 tons	41.2 tons
Kind of coal burned.	Welsh	Black vein and Merthyr mixed	Ayrshire
Percentage of ashes.	13.6	11.7	12.3
Date of trials.	December 7, 8 and 9, 1892.	April 30 and 21, 1894.	February 25, 1894.

This table shows that, of the three apparatus, the one that gives the least favorable results produces still more than 32 tons of distilled water per ton of coal burned. If we add the distilled water which returns from the first cylinder to the boiler, we obtain 41 tons of distilled water per ton of coal burned. This practical result has even been exceeded.—Revue Industrielle.

THE THEISEN MOIST AIR CONDENSER.

It is well known that, in principle, a moist air condenser consists of one or more bundles of tubes traversed by the steam to be condensed, and moistened externally by water that gradually evaporates in the open air and is collected in a vessel, whence it is sucked up by a pump and forced into the apparatus again. At the same time, a blower maintains upon the evaporating tubes a current of air that becomes saturated with the vapor disengaged by the moistening water.

Under such circumstances, the transmission of the heat is rapidly effected with a very feeble output of water, since it merely suffices to compensate for the losses due to evaporation. As it is admitted that the latter amount only to three-fourths of the weight of vapor, it may be said that, theoretically, condensation by moist air does not require any water, since the vapor furnishes more than the moistening demands. There is here a great advantage over condensation by injection, to speak only of the latter.

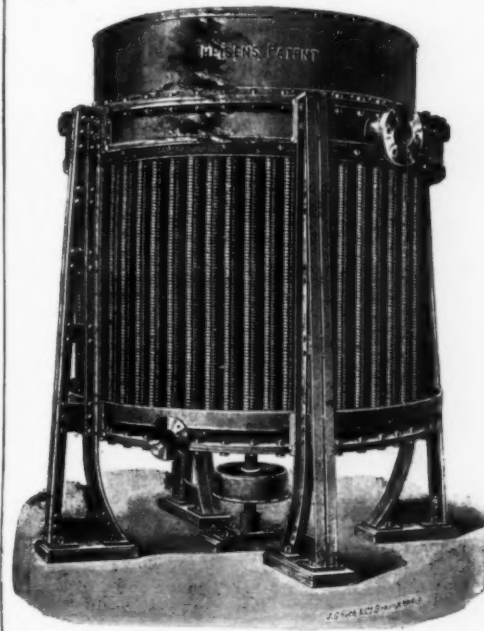
But, for its realization, a moist air condenser presents certain difficulties due to the fact that it must be very powerful under a feeble bulk and be accompanied with efficacious means of freeing its parts from the external incrustations that have a tendency to form with rapidity to the great detriment of conductivity. Mr. Edward Theisen has been enabled to overcome these difficulties skillfully in the apparatus that he has devised and which is represented in the accompanying figure.

This condenser is formed of numerous vertical copper tubes arranged circularly and joined at their extremities to two drums. Into the upper one of these the waste steam enters, while the condensed water is extracted from the lower one by an air pump.

Each tube of the bundle is surrounded, with slight friction, by a spiral of wire that forces the moistening water coming continually from above to run with rapidity around the tube and flow in continuous thin sheets along the spirals, whose size and pitch are properly calculated. Thanks to this artifice, the tubular surfaces are all kept perfectly moist for their entire length, while at the same time they are uniformly swept by a current of air set up by a central blower, whose driving pulley is visible at the lower part of the

apparatus. Not only do the spirals contribute toward distributing the moistening water over the tubes, but they also render its adhesion such that no particles of liquid can be carried along by the current of air. These spirals, besides, afford a means of rapidly freeing the tubes from the incrustations with which they may become covered. The operation is performed even during the running by sliding these elastic spirals along the tubes, that is to say, by compressing them alternately upward and downward. In this way, all the incrustations are detached from the tubes and carried along by the non-evaporated water to the bottom of a vessel situated at the base. This water is taken up by a small centrifugal pump and continuously forced to the top of the spiral-covered tubes.

The intervals between the latter are so calculated as



THE THEISEN MOIST AIR CONDENSER.

to permit of the circulation of large quantities of air along the spirals and of thus obtaining a great evaporating power.

Upon the whole, the arrangements of this condenser are most simple, and assure it a regular operation, with a constant rendering and slight expense. Owing to the great saving in water effected, as compared with condensation by injection, many large establishments run by several steam engines provided with independent condensers might advantageously substitute for the latter one Theisen central condenser. It is to be remarked that, by reason of the facility with which it is run, this apparatus is of easy installation in an elevated position, at the top of the boiler house of a factory, for example.

Mr. Messmer has just made known to us a new application that is now under study, and that will consist in the cooling of wires at the epoch of fermentation, in order to cause them to preserve the quality that the latter tends to make them lose.—Revue Industrielle.

THE MEASUREMENT OF POWER.

BRAKES AND DYNAMOMETERS.

By G. D. HISCOX, M.E.

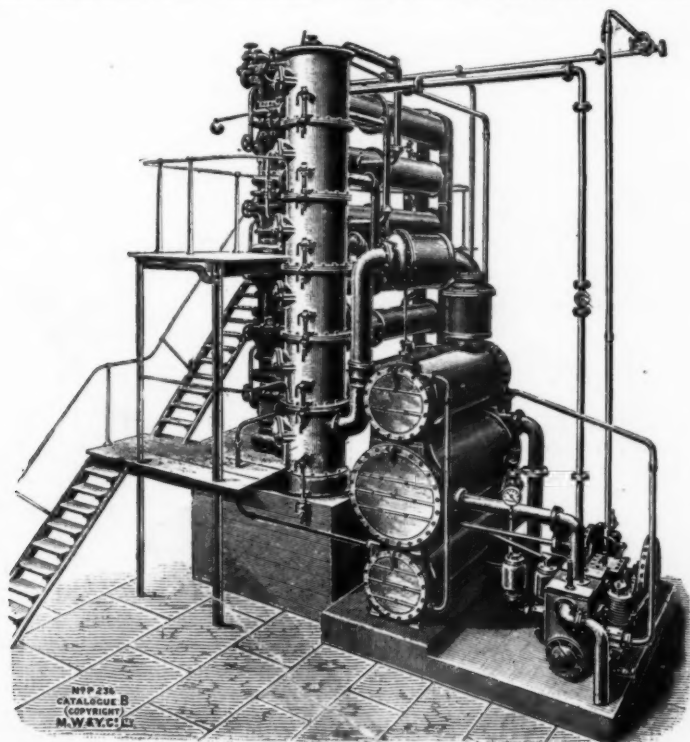
THE useful work of a prime mover, as delivered through its main belt or gear, and the actual work required to drive a system of shafting in a mill or factory, and incidentally of any individual machine, are points of financial importance to all interested in the use of power.

Where a system of renting of power to tenants exists, or the transmission of power to a distance is desired, the exact amount of power let or transmitted and the amount received by power tenants are most important elements in the relation of lessor and lessee, which bear largely on the success of manufacturing enterprises, as well as on their legal aspects in cases of misunderstanding or of unsatisfactory reference and judgment between interested parties to power contracts as to the absolute amount of power used or transmitted.

The methods of measuring power are but of two general forms or principles, although the individual machines or instruments for accomplishing the measurement are of many kinds and of a variety of construction.

The one form is especially adapted for the measurement of the available power of prime movers under the various conditions of the application of their elementary constituents, by the absorption of their whole output of power at the point of delivery and there record the value of its force and velocity. Its representative is the brake dynamometer, or Prony's brake, in the various details of construction that it has assumed as designed and applied to meet the views or fancies of mechanical engineers.

The second form is a marked departure from the structural form of the first, and with the principle in view of placing as little obstruction as possible to the transmission of power from the prime mover to the receiver of power, to measure the actual net or differential tension of a belt or gear, and with its velocity indicate the exact amount of power delivered to a line of shafting or a machine. These are called transmitting dynamometers in distinction from the absorption dynamometers of the Prony type. They are of two kinds, one with a dial and index pointer, by which the



IMPROVED DISTILLATION APPARATUS.

hand on the dial must be constantly watched and recorded for a length of time and a mean pressure obtained from the varying record. The other carries a self-marking register moved by clockwork, by which the actual pressure is a constant record for any desired time, or a full day's work, the only personal ob-

face of the pulley, fly wheel or shaft upon which friction is applied, B the length of the lever from the center of the shaft to the point of the scale suspension, A the radius of the pulley fly wheel or shaft, and R the number of revolutions of the shaft per minute: The weight used in the formula must be the net weight of

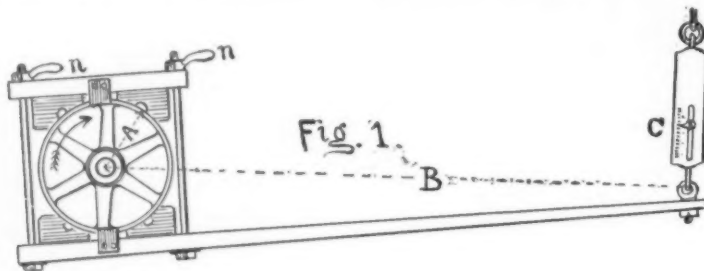


Fig. 1.

servation required being the speed of the pulley or belt or its average throughout the time or day.

In Fig. 1 we illustrate the first form, a simple absorption dynamometer or Prony's brake, from the inventor's name, in which A is the radius of the pulley drum or shaft to which resistance may be applied, B the length of the lever from the center of the shaft to the point of attachment of the spring scale or other means of measuring the tension of the lever, C a spring scale, which is preferable for light work within its range, and N N lever nuts for quick control of the pressure.

In Fig. 2 is presented a simple and inexpensive arrangement of a power-absorbing brake for a large driving pulley or finished fly wheel, in which a belt is lined with blocks of wood spaced and fastened to the belt with screws or nails; a few of the blocks projecting over the edge with shoulders to prevent the belt from running off the pulley.

Spring scales may be purchased of the straight and dial pattern up to one or two hundred pounds capacity at reasonable figures, and are a source of satisfaction in showing the amount of vibration due to irregular pulsations of the motive element and crank motion. Where the measurement of power beyond the range

of the power stress, or the gross observed weight less the weight of the lever. Then

$$\frac{D \times 3.1416 \times R \times \frac{B}{A} \times \text{weight}}{33,000} = \text{horse power}$$

$$\text{or } \frac{B \times 6.2832 \times R \times W}{33,000} = \text{horse power}$$

B \times weight = the stress or pull at the face of the A pulley, and $D \times 3.1416 \times R$ = the velocity of the face of the pulley or of the belt that it is to carry.

In Fig. 3 is represented a simple and easily arranged dynamometer for small motors of less than two horse power. A piece of belting held in place on the pulley by clips or only strings fastened parallel with the shaft to keep the belt from slipping off; two spring scales, one of which is anchored and the other attached to a hand lever to regulate the compression of the belt upon the surface of the pulley, when the differential weight, B-C, on the scales may be noted simultane-

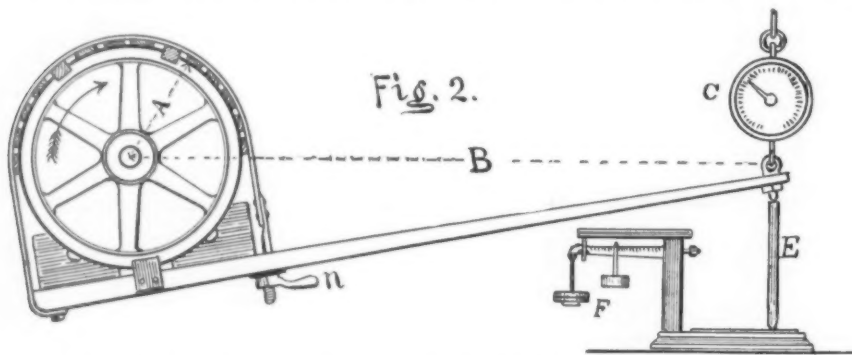


Fig. 2.

ously with the revolutions of the pulley. The simple formula

$$\frac{D \times 3.1416 \times R \times \text{differential weight}}{33,000} = \text{horse power.}$$

Another form, Fig. 4, is a more convenient one for larger powers than Fig. 3, and well adapted for pulleys of water wheels and turbines in pits; as the belt connections can be extended to any desired length, placed horizontal for a vertical shaft, or when inverted for a pit wheel, a rope or several ropes may be substituted for the belt. The pressure of the belt or ropes upon the pulley face may be regulated by weights on a rope over a sheave or a lever as at A, and a counterbalance on the lever as at F. With this form, when in action, the whole weight as read on the scale, C, is used in the formula.

The differential tension of the belt or rope friction is compensated by opposite strains as in Figs. 1 and 2,

$$\text{and the formula } \frac{B \times 6.2832 \times R \times W}{33,000} = \text{horse power.}$$

In which B is the length of the lever from the fulcrum, W = the whole weight shown on the scale; C and R, number of revolutions per minute as before named.

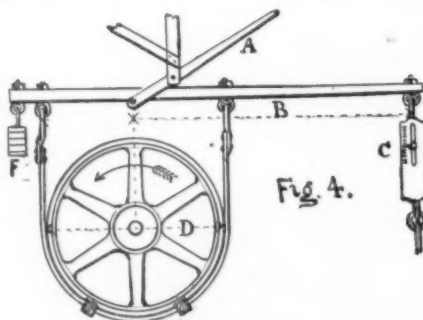


Fig. 4.

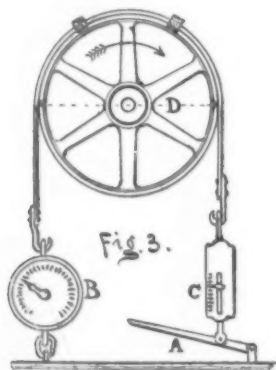


Fig. 3.

lever or the relative direction of the motion of the pulley, as shown in Figs. 1 and 2, then the weight of the lever must be added to the weight shown by the scale under trial. When the platform scale is used the weight of the lever must necessarily be downward and should be deducted from the weight shown by the scale under trial. Making D equal the diameter of the

Fig. 5 illustrates a rope absorption dynamometer or brake with a complete wrap on the surface of the pulley, very suitable for grooved pulleys or fly wheels used for rope transmission. In this form the friction tension may be regulated with a lever as at A. The weight (W) in the formula is the differential of the opposite tensions of the two scales, or $B - C = W$, Fig. 5,

and the formula will then be $\frac{D \times 3.1416 \times R \times W}{33,000}$ = horse power as in the notation, Fig. 3.

For a lengthy test the traction recording dynamometer, Fig. 16, may be used to advantage, as by the

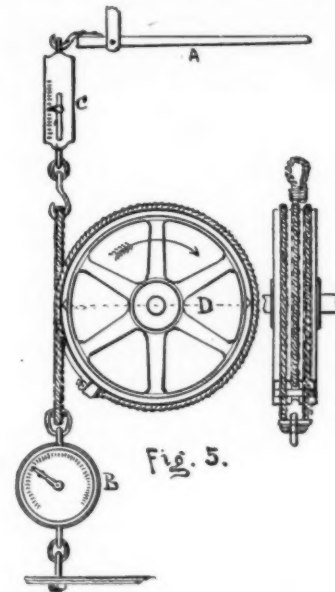


Fig. 5.

continuous record card the mean effect of a varying power may be obtained. The measurement of a subdivision of power to various lines of shafting, to special machines and to power tenants, becomes of great importance in a business view and beyond the powers of the absorption system of measurement. For this purpose the transmission form of dynamometers are used, and of which some of the leading forms are selected. In Fig. 6, the Webber balanced or differential dynamometer is represented; the essential feature of which is the box or compound bevel gear, consisting of two shafts in line, each carrying a bevel gear, mitered with a pair on the balanced lever; the lever and its gears having a free movement bearing on the ends of the two shafts in line. The equal spur gears at the opposite ends of the shafts from the pulleys are only needed to allow of the same direction of revolution in the belt pulleys and its alignment. The dash pot, G, consisting of a loose piston in an open cylinder

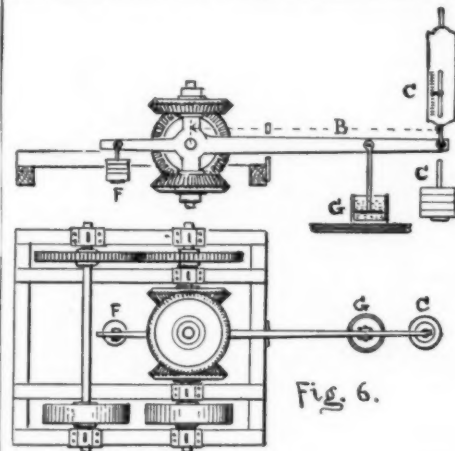


Fig. 6.

of water, tends to steady the position of the lever, yet allowing it to move freely between the stops. The lever being balanced by the weight, F, the measure of the belt pull is in proportion to the leverage and

$$\frac{B \times 6.2832 \times R \times W}{33,000} = \text{horse power}$$

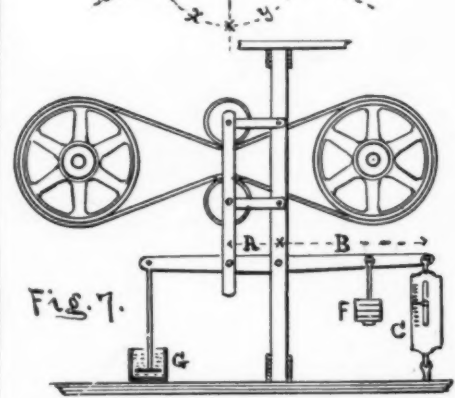
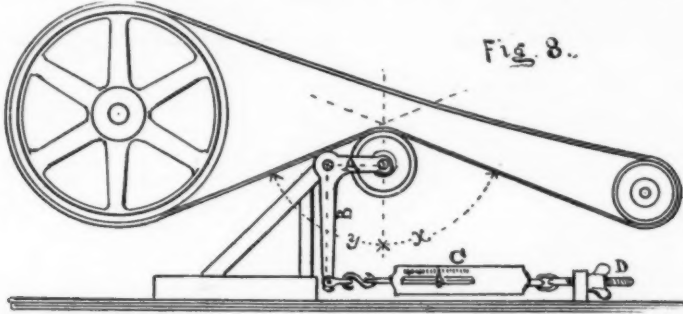


Fig. 7.

R × W
g dynamo-
as by the

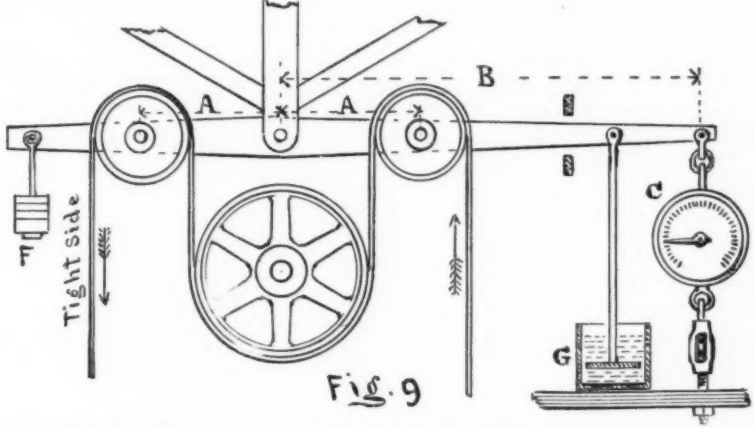
power; in which B is the length of the lever from the center of action in feet, 6.2832 is twice the circumference in units of B, or feet, R number of revolutions of the pulleys per minute; both pulleys being of the same diameter.
As this style of dynamometer requires the dividing



of a belt, which is not always desirable, the exponent of the lateral stress upon a single belt led Mr. Robert Briggs to design the form and its principles as shown in Fig. 7, where the differential tension of a single belt at rest and under stress of delivering power was measured by the lateral pressure on a scale beam. This also involves the exact measure of the belt angle on the tension side of the belt; the measured strain due to work being in a vertical line running through both tension pulleys and their lever connection. If both angles are alike, then twice the lateral pressure on the belt, divided by the cosine of the angle x or y, as in the cut, will be equal to the power stress of the belt, which multiplied by its speed in feet per minute is the

difference in the stress on the upper and lower belt can be observed very accurately by the lateral thrust of one tightening pulley against the lower belt.
The arrangement of the bell crank lever and scale is sufficiently shown in the cut, and only the caution to have the position of the center lines of the bell crank

Fig. 8.
The formula $\frac{W \times B}{A} \times \text{belt speed in feet per minute} = \text{foot pounds, and } \frac{\text{foot pounds}}{33,000} = \text{horse power transmitted.}$
lever, B, so adjusted at the moment of observation as to cut the belt angle at equal division, or if not to observe the inequality and use the mean of the two cosines instead of twice the cosine, as in the last example.



foot pounds power. Then with the tension on the belt balanced by the counter weight, F, and the scale, C, at 0, when the belt is at rest, and $\frac{B}{A}$ = the terms of the lever, W = the scale measure with the power stress on the belt; the formula $\frac{W \times B}{A} \times \text{velocity of belt in feet per minute, and last product, divided by 33,000, equals the horse power. If the angles, x and y, are not equal by difference in size of pulleys, the mean of the cosines of each angle will be required in the equation. In this arrangement the position of the lever must be maintained by adjusting the scale, C, to suit the required position of the lever when the stress comes on the belt.}$

With this arrangement, a dash pot and the recording traction dynamometer, Fig. 16, may be used for a continuous record of irregular power transmission.
In Fig. 9 is illustrated the principle of Tatham's dynamometer arranged for a vertical belt. The two tension pulleys set in a framed lever over a driving or driven pulley with counter weight, F, and dash pot, G, are balanced when the belt is at rest. The pull of the belt under power strain is direct upon the lever and is measured in terms of the lever, B, and scale, C. The work of the belt results from formula, $\frac{W \times B}{A} \times S$ = horse power, where W is the scale reading in pounds, S the speed of the belt in feet per minute.

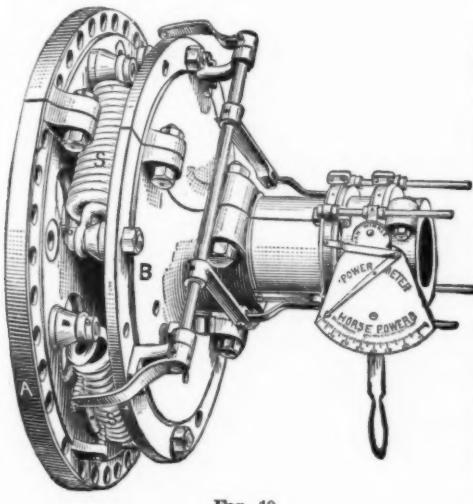
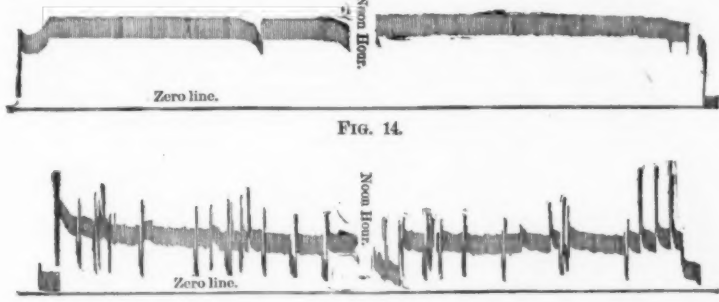


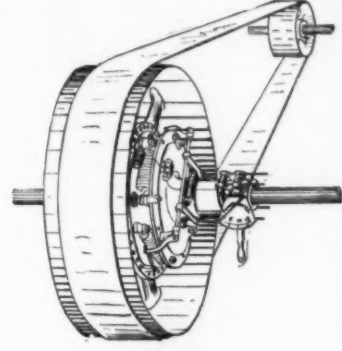
Fig. 8 shows a modification of the principle of the Briggs dynamometer for testing the power required to run dynamos, or of motors, electric or others, by the stress on the power side of their belts.
So long as the slack side of the belt is kept in the same curve when the belt is stationary or running, the

The form of dynamometer that admits of a direct measurement of the belt power tension by means of a spring or a number of springs of known tensional value and applied directly to the belt pulley, which for the time of measurement is made loose on the shaft, while the dynamometer is clamped to the shaft, is as yet the most perfect means of measuring power in transit. Of this class, Figs. 10, 11, and 12 show the details of the F. Van Winkle power meter, consisting of a pulley plate, A, bolted to the arms of the driving or driven pulley, to which is attached one or more studs for holding the looped ends of the helical pull springs, S, S.
Another plate, B, with a sleeve is clamped to the shaft, also having studs to hold the other end of the

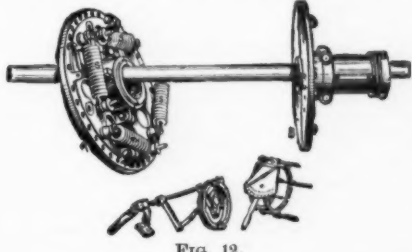


springs. Upon this shaft plate is fitted a small rock shaft with arms to operate like a bell crank; one arm being connected to the movable plate and pulley, while the other arms move a sliding collar upon the shaft plate sleeve, holding a runner ring. The studs in this transverse runner carry another runner ring in a fixed

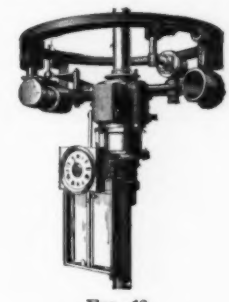
groove on the end of the shaft sleeve, to which is attached a dial and pointer; so that while the shaft is turning, the registering dial may be held stationary for reading the amount of the extension of the springs by the movement of the pointer over the scale, as shown in the cut, Fig. 10. When the increments of



weight or belt pull and corresponding extension of the springs are obtained by trial, the dial scale can be computed from the known elements of the levers and scaled on the dial plate; after which an actual test may be made by a brake. The analytical method, taking into account variation of leverage and the varying radial distance of the tangent line of spring tension, is preferred for accuracy. The pivotal bearings of the lever



system which transmits the motion to the index hand, having practically no work to perform, are made small in size and a snug fit. The wear of the joints after much use is found to be so small that the back lash is not observable, nor is there any deviation in the reading of the index by the effect of centrifugal force upon the levers, they being counterbalanced.
The measured values of force on the scale and the



computation of a definite radius become the factors in the computation of the transmitted power.
The formula then becomes:
Index pressure × radius of tangent center line of springs × 6.2832 × revolutions per minute and the product divided by 33,000 = horse power transmitted.
The design of the scale is to primarily measure force at a fixed radial distance, but may be made to represent horse power for an assumed definite speed of rotation, from which the horse power for any other speed will be in proportion to the relative speeds, so that if a permanent scale for 100 revolutions be made on the dial, a simple inspection of the dial gives a mental ratio for any other speed.

The inventor of this dynamometer has a sliding scale adapted to these instruments, by which the power for various speeds may be instantly read by the set of the scale to the actual speed of the shaft under trial.
The continuous registering dynamometer of A. B.

Wood & Son is shown in Fig. 13. A reduced facsimile indicator card, Fig. 14, of the registration for one day of a uniform power in running a large Sturtevant blower, and Fig. 15, a card representing the variable power of a line shaft running printing presses. The great range of power in starting and its release by stopping, or when running idle in complex machines, like a large printing press, are most important points in the study of machine power.

This dynamometer has a dash pot with a regulating fluid of oil or glycerine, which gives an easy change of piston place without vibration and a clock to regulate the travel of the registering sheet.

The dynamometer proper consists of a ring clamped to the arms of a loosened pulley, a plate and sleeve clamped upon the shaft with cups on ring and plate to receive two or more compression springs; a lever and toothed segment attached to the plate and connected

PRACTICAL MEASUREMENT OF THE VELOCITY OF THE WIND.

At one of the last sessions of the Academy of Sciences, the eminent Mr. Janssen, in speaking of the interesting work done at the Observatory of the Eiffel Tower, made obvious the advantage that may be derived from this station, which is placed under exceptional conditions for the study and verification of a large number of physical laws that are as yet not well elucidated.

The tempest of exceptional violence that prevailed over France, and particularly over Paris, in the first fortnight of November has given a new proof of this as regards the important question of the measurement of velocity and pressure of the wind.

Let us recall the fact that these two elements—the velocity and force of the wind—intervene in a prepon-

strikes. Such pressure must be afterward deduced by calculation from the formula:

$$P = 0.12348 S V^2$$

in which P designates the pressure in kilogrammes per square meter, S the surface struck by the wind in square meters, and V the velocity of the wind in meters per second.

With this formula, we find, for example, that for a wind velocity of 33 meters per second, the pressure is 133 kilogrammes per square meter; and for a velocity of 45 meters per second, the pressure is calculated as 247 kilogrammes per square meter.

Are these figures exact and real? Our builders of great metallic frameworks, bridges, viaducts, etc., take them as a basis for the present, but they very well know that great winds sensibly double the stresses to which a certain number of pieces of their constructions

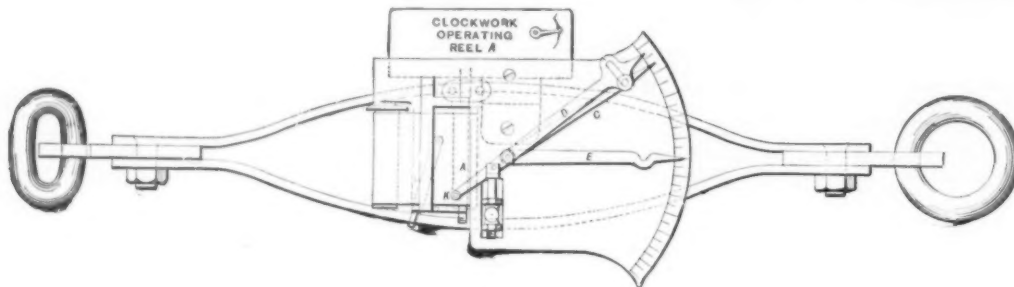


Fig. 16.

with a geared collar or ring running loosely on the shaft sleeve, which in turn operates two small pinions and ratchet bars, giving a longitudinal motion to a sliding collar and runner ring, also on the shaft sleeve, thus allowing the clockwork and registering sheet hanging upon a second running ring to remain at rest for observation of the record.

A scale made to represent the pressure of the springs corresponding with the position of the recording pencil shows at once, by comparison with the zero line made by a stationary pencil, the pressure at the radius of the center line of the springs. Then the measured pressure by the record multiplied by the velocity of the spring center radius in feet per minute gives the foot pound force, which, divided by 33,000, gives the horse power transmitted, or if the term of pressure on the scale is made for a given size and speed of pulley, then the speed of the belt is made the velocity factor in the scaled measurement of power. A scale of horse power for any assumed speed may also be used, where the variation of the speed under trial becomes a proportional function of the assumed scale.

Such is the delicacy of movement in the two last dynamometers that differences of one-thousandth of a horse power may be detected in their record.

In this way the dynamometer becomes a valuable instrument for determining the actual power required for operating all kinds of machinery.

The value of the power required for running the individual machines of mills, factories, machine shops, printing establishments, and wherever power is used, is of the greatest importance to the users as well as to the designers of machinery and power plants.

For obtaining the draught power of traction engines and horses on roads, or the power required for hauling wagons, cars, plows and other implements by the use of rectilinear force, the Giddings traction recording dynamometer, Fig. 16, is a most useful and efficient instrument for showing a continuous record of a traction load.

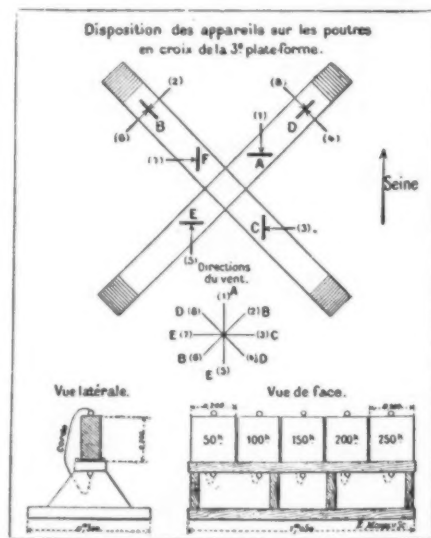
A sample of its work is shown in the indicator card, Fig. 17, which is a reduced facsimile of a trial record sheet.

This dynamometer consists of a pair of elliptical steel springs joined at the ends with links for attachment to load. To one of these springs is attached the dial plate, graduated to the power of the springs, and also the pivoted index hands.

To the opposite spring, by means of an adjustable connection, is attached the extension of the index pointer, C, carrying the pencil at K. The slotted index pointer, D, has a slight friction on the pivot and serves as an averaging hand to the reading of the pointer, C. Another frictional pointer, E, is moved to the maximum strain by the pin in the pointer, C, and

derant manner in the calculations of structures erected by our engineers, and, principally, of metallic works. According to the value attributed to them, their coefficients have a profound influence upon the dimensions of the constructive pieces used, and, according as such or such a value is attributed to them, the structure is made more or less heavy or more or less light.

Now, although there are traditions, in a manner, on



Arrangement of the Apparatus Designed for Measuring the Stresses Exerted by the Wind upon the Eiffel Tower.

this subject, and although treatises upon the strength of materials and vade-mecums furnish generally admitted figures, it must be recognized, on the contrary, that experiments and observations properly so called are not numerous. Their rectification, made with that exactitude that in our day one likes to put in scientific observations, is capable, perhaps, of leading

are submitted. Their remedy is to add bars and lattices that are to put the resistance of the structure in accord with the calculation. In a word, they obey the formula by prudence. Now, it seems to result from some direct experiments recently made at the Eiffel Tower by Mr. Koechlin, an engineer who has been one of its imitators, that the formula in question gives very exaggerated results.

Here is how Mr. Koechlin proceeded in this investigation:

He installed upon the tower some apparatus that were very elementary, but of undoubted correctness as to indications, and that were devised by him. These apparatus, six in number, are, as shown in our figure, arranged so as to present themselves normally to the wind, for eight different directions, that is to say, one apparatus makes an angle of 45° with the following.

Each of these apparatus consists of cast iron parallel-pipedons whose dimensions have been so calculated as to be overturned by a wind of determinate intensity. Upon this subject some precise researches are making in the laboratory with the aid of compressed air.

The parallel-pipedons are five in number and are placed one alongside of the other. They are overturned under pressures of 50, 100, 150, 200 and 250 kilogrammes per square meter of surface. They are mounted upon a very light wooden frame, which, by reason of its flying surfaces, offers no purchase to the wind.

With these elementary apparatus, one is certain of the upset thrust exerted by the wind upon one square meter of surface, from 50 to 50 kilogrammes. In fact, their moment of stability is mathematically established. It can be destroyed by no external circumstance other than the power of the atmospheric current. Now, if we consider the great tempest of the 12th of November last, while the anemometers were indicating as many as 45 meters per second of wind velocity, the parallel-pipedons of 100 kilogrammes indicated pressure were overturned, while those of 150 kilogrammes and the following ones remained in place. According to the usual formula that we have cited above, the parallel-pipedons of 200 kilogrammes ought to have been overturned under such conditions, since, at the velocity of

$$V = 45 \text{ meters per second}$$

there corresponds a calculated pressure of 247 kilogrammes per square meter. The wind has therefore been able to approach a maximum pressure of 150 kilogrammes, without exceeding it. The difference in round numbers is at least 40 per cent. between the result of the formula and the reality.

Certainly, such difference is of a nature to make us perfectly easy as to the resistance of the existing metallic structures to the wind, but it evidently corresponds to an exaggeration in the use of materials. It will be conceived also, in starting from this statement, why it is that certain large structures, factory chimneys, for example, considered as being of extraordinary boldness, have never been overturned, despite the formulas that rendered them disquieting. They were simply logical. Professional men will be able to put to profit the excellent lesson, not yet published, that Mr. Koechlin has just given them.

Let us add still another technical detail that enters into the same order of ideas. At the time of the construction of the 300 meter tower, the amplitude of the possible oscillations of this great isolated column, under the future stress of storms, was the object of numerous hypotheses. The most moderate estimated them at 10 or 15 centimeters for a tempest like that which recently became unchained. Calculation indicated about 45 centimeters. In reality the amplitude was from 4 to 6 centimeters. This was formally ascertained by means of a telescope installed in one of the legs of the tower and which pointed toward a graduated disk established at the summit. This apparatus gives a very exact measurement of the oscillations, which, in this great elastic structure, are damped in a remarkable manner.

When bridges being put in place are thrown to the ravine or when the chimneys of a factory are overturned by a hurricane, it is therefore not to the great instantaneous amplitude of their oscillation that the disaster must be attributed, but to the successive ac-

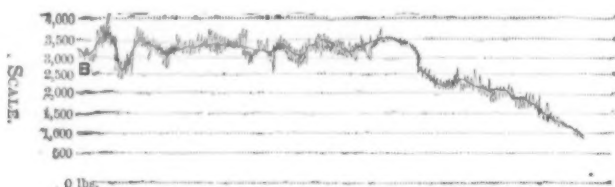


Fig. 17.

remains for observation. To the spring carrying the dial plate is attached the clock movement and two spools or barrels upon which the record paper is wound. The record paper, if cut to truly fit between the flanges of the spools, may be ruled to indicate the reading of the pointer on the dial, or a scale may be prepared to use on the record strip.

We have selected the types of brakes and dynamometers here represented from more than thirty that have been in use or published during the past forty years, for their simplicity and ready application, although there are several that have been designed and used for special or peculiar service that we have left out for want of space in the columns of a journal,

to a better utilization of the materials brought in play by the art of the builder.

It is to this intent that Mr. Mascart has arranged, in the first place, upon the summit of the Eiffel Tower a series of apparatus for registering the velocity and force of the wind, and among which there is an anemometer that operates in connection with the Central Meteorological Bureau of France, which notes its indications.

The types of anemometers used are numerous and well studied, and they properly measure the velocity of the atmospheric currents, but they do not give in a simple and direct manner the amount of the pressure that the wind exerts upon the surfaces that it

accumulation of the oscillations, which alone is capable of displacing the mass by a work of a certain duration, and of finally effecting the overthrow. The practical researches that we have just summarized are, we may say in conclusion, far from rendering calculation useless. They give it, on the contrary, a certain basis that it lacked in points of essential details.—La Nature.

TREATMENT OF AURIFEROUS ORES WITH BROMINE.

By C. LOSSEN.

VARIOUS procedures have been made known of late for the treatment of auriferous ores with bromine, especially as a substitute for chlorine.

Although it was found practicable to reduce the consumption of bromine to a minimum (down to $1\frac{1}{2}$ lb. per ton), its application on the large scale has not become general, and the operators always returned to chlorination.

After prolonged experiments I have succeeded in developing a process for the recovery of the bromine used in the extraction of the gold, so that the working cost is considerably reduced.

The simplest and cheapest method of liberating bromine from any compound is by means of the electric current. A solution of potassium bromide is decomposed by the current, so that, on introducing a diaphragm of asbestos cloth, a solution of bromine in potassium bromide is separated at the positive pole, while potassium hydroxide is produced at the negative pole. By the diffusion of both solutions through the diaphragm there are always formed certain quantities of hypobromites and bromates. But if such a solution is decomposed without the introduction of a diaphragm, there results an alkaline liquid, which, of course, cannot contain free bromine, but which has the property of dissolving leaf gold.

I reserve a more complete account of the method, and will here merely give the principal points of the process as about to be introduced at a mine in Oregon.

The ore, green or roasted, is mixed with an alkaline solution of bromine in a cylinder, which is maintained in rotation until all the gold is dissolved. If the mass is no longer alkaline, a second portion of the bromine solution is added before the mass is introduced into the filtering vessels. The gold is not precipitated, but remains in solution as an aurate, while iron and other metallic salts remain as hydroxides and the bromine is dissolved as potassium bromide. The filtered solution then flows, for the recovery of the gold through tanks filled with a mixture of iron and carbon, or coke, whereby the gold is entirely precipitated. The solution, free from gold and containing chiefly potassium bromide, flows into long troughs, in which it is decomposed by the electric current, and can then, as a solution of alkaline bromide, serve for the treatment of fresh quantities of ore.—Berichte Deutsch. Chem. Gesell.; Chem. News.

A GUIDABLE PARACHUTE.

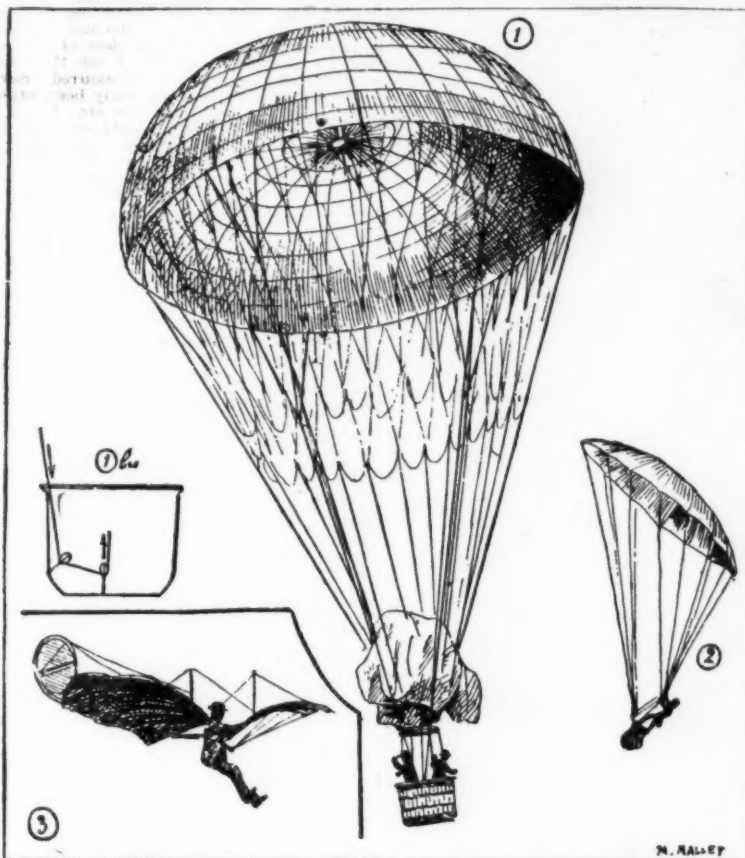
ACCORDING to a Paris correspondent of the London Daily Graphic, M. Coppazza believes that the expanded parachute can be directed in its fall. For this purpose he has adopted the plan shown in the sketch. By three different smaller lines he attaches a rope to each of the two extremities of two rectangular diameters, each rope being designed to pass round two

pulleys, fixed one on the side of the car and the other on the bottom. M. Coppazza considers that he may thus send his apparatus in any of these four rectangular directions by drawing the corresponding line through the sheaves of the two pulleys. This risky

AN IMPROVED SAIL RIG FOR VESSELS.

To the Editor of the Scientific American:

I send you a rough drawing of sails and rigging for a sailing vessel of from 300 to 700 tons, simply adding

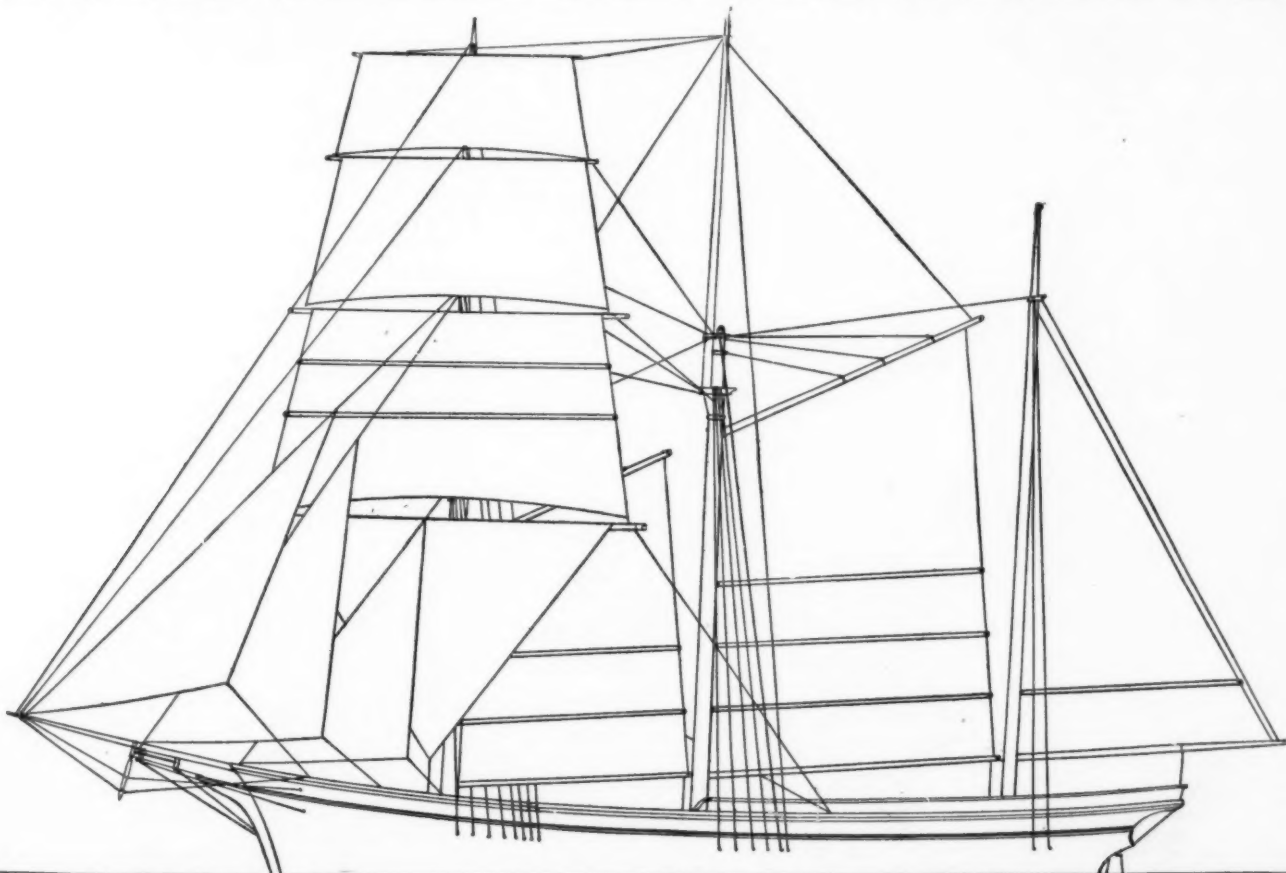


1. M. Coppazza's balloon parachute. 1 bis. One of the ropes by means of which the parachute is to be guided. 2. Common method in France of directing the fall of a parachute. 3. A new flying machine.

A GUIDABLE PARACHUTE.

scheme may be considered as a sort of systematizing of a practice common among the French parachutists when nearing the land. By climbing on the edge of their car and grasping some of the ropes they are destroying in the same manner the equilibrium of their falling machine, which is sent sideways and so is prevented from being precipitated on a tree or building.

more masts if the size is increased. The advantage of rig and sails over that of three or four masted vessels is that it gives square sails forward with which to run in strong winds (as scudding) with the least possible risk. The great danger in sailing large fore and aft schooners running before strong winds is their liability to jibe, at which time the danger of carrying



IMPROVED SAIL RIG.

away gaffs, booms, sails and masts is great. The rig shown obviates this difficulty. The sails are all easily handled. The mainsail, although a large sail, is like that of a fore and aft schooner, but all inboard. Some of the sails are of such dimensions as to be always available for storm use. The triangular sail on the mizzen mast, the fore and aft foresail, equal to a schooner's foresail, double reefed, the fore and foretopmast staysails, are all storm sails and entirely wanting in all large schooners. The triangular foresail has but a single stationary tack at the deck, and is equally good either by or before the wind, with the advantage of being easily handled. The triangular spanker may be jibed at any time without danger, and is most readily handled; and when lying to in a gale and required to wear ship, it runs down readily, and easily hoisted by two men as soon as the vessel is before the wind, and is very effective, being always a storm sail. The square sails every sailor will appreciate; in fact, no vessel at sea is complete without some.

You will perceive at once that I am not a draughtsman, but a practical seaman, having given considerable attention to planning and the construction of vessels and sailing them around the globe.

CHAS. E. ROULETT.

Auburndale, Mass.

(Continued from SUPPLEMENT 991, page 15840.)

EXPERIMENTS IN AERONAUTICS.*

By HIRAM S. MAXIM.

IN regard to the stability of the machine, the center of weight is much below the center of lifting effect; moreover, the upper wings are set at such an angle that whenever the machine tilts to the right or to the left, the lifting effect is increased on the lower side and diminished on the higher side. This simple arrangement makes the machine automatic so far as rolling is concerned. I am of the opinion that whenever flying machines come into use, it will be necessary to steer them in a vertical direction by means of an automatic steering gear controlled by a gyroscope.

Many have supposed that the condensation of steam would present insurmountable obstacles to the use of a steam engine on a flying machine. The surface condenser, as used for marine purposes, consists of a box nearly filled with a multitude of small tubes. Water, the cooling agent, is pumped into one end of this box, and discharged at the other through relatively small openings. A condenser made on this plan would be very inefficient, because the actual volume of air required to condense the steam is about 2,400 times as great as the volume of water required. The tubes of an atmospheric condenser, instead of being arranged in dense and compact masses, have to be spread out over a great deal of surface, and, instead of having air pumped through them, the tubes themselves are driven through the air. I have found it to be advantageous to make the tubes in the form of very thin aeroplanes, and to drive them edgewise through the air; in this manner an enormous volume of cold air is encountered. No air that has been heated by one tube ever touches another tube; moreover, the heating surface over which the same air passes does not exceed two inches in width. With a condenser properly made and arranged, I find that the air will not only condense all the steam into water sufficiently cold to be pumped, but it will also exert a lifting effect on the condenser considerably greater than the weight of the condenser and its contents. When the condenser is placed immediately after the propellers, the slip of the screws may be added to the speed of the machine; for instance, if the machine be traveling through the air at the rate of 50 miles an hour, and the slip of the screws be 15 miles an hour, the air would be driven through the blades of the condenser at the rate of 65 miles an hour. At this speed the cooling effect is very great. I have not yet finished my condenser experiments, but as far as I have gone, I feel sure that a copper condenser can be so constructed that it will return its own weight in water every five minutes, or if aluminum is used, every two and a half minutes.

As to the weight of the motor complete, including 200 lb. of water in the boiler and 600 lb. in the condenser and tank, I think I may safely assert that it need not be more than 11 lb. per horse power, that is if the steam engine is employed. If, however, a special internal combustion engine should be designed, it would of course require less weight of water and condenser; in this case the weight could probably be reduced to about 9 lb. per horse power. One pound of naphtha will generate about as much steam as two pounds of coal, and it would probably require rather more than a pound per hour to run a steam engine, but with the internal combustion engine it is well known that one pound of fuel will develop one horse power for one hour.

In Professor Langley's experiments, he succeeded in carrying as much as 250 lb. per horse power with very small planes mounted at a very slight angle, and driven at an exceedingly high speed. In my early experiments I used aeroplanes 20 to 100 times as large as those employed by Professor Langley. I mounted them at a steeper angle, and succeeded in carrying 133 lb. to the horse power, but in both cases the power referred to only relates to that which was actually required for driving the aeroplane itself through the air. When, however, it becomes necessary to drive the boiler and the engine and a considerable amount of framework through the air, and when we have the slip of the screws to deal with, the amount of weight that may be carried with one horse power is greatly reduced. With my large machine as first finished, the actual lifting effect was less than 28 lb. per horse power, but then this is the first large machine ever built, and is susceptible of many improvements, every one of which will increase the load which the machine will be able to carry with the expenditure of one horse power. In designing a new machine, the advantages of my past experience will enable me to improve and simplify it, so that I shall be able to carry from 50 lb. to 60 lb. per horse power; and I have no doubt that we shall shortly be able to carry as much as 100 lb. to the horse power. Even with only 50 lb., a machine could travel from 250 to 300 miles and return to its point of departure, practically a flight of 500 to 600 miles.

* Read before the Society of Arts, London, November 25, 1894. From the Journal of the Society.

Up to the present time my experiments have been conducted, for the most part, to ascertain whether it would be possible or not to construct a machine which would be powerful enough to raise itself into the air. When I commenced my experiments with automatic guns, the first time that the energy derived from one round loaded and fired the second round, I was certain that the automatic system would be a success. Likewise, on the first occasion that my aerial apparatus lifted itself clear of the track by the energy of its own engines, I felt that the ultimate success of flying machines was assured. Several European governments have recently been experimenting with a view of navigating the air. It has long been known that if a machine could actually be made to fly at a velocity greater than that of the wind, it would be a most potent engine of war, and the nation first to make itself the master of the air would have an immense advantage over those less fortunate.

Nearly all, however, have attempted to solve the question by improving the balloon, and, as a matter of fact, it has not been generally believed that a machine could be made to rise in the air without a gas bag. Now that it has been proved that a machine can be made to raise itself from the ground by its own energy after the manner of a bird, and that there is nothing whatever to prevent it traveling at a high velocity through the air, I think it will not be long before we shall have, at least, military flying machines. It will certainly not be more difficult to maneuver and steer such machines than it is to control completely submerged torpedoes.

When the machine is once perfected, it will not require a railway track to enable it to get the necessary velocity to rise. A short run over a moderately level field will suffice. As far as landing is concerned, the aerial navigator will touch the ground while moving forward, and the machine will be brought to a state of rest by sliding on the ground for a short distance. In this manner very little shock will result, whereas if the machine is stopped in the air and allowed to fall directly to the earth without advancing, the shock, although not strong enough to be dangerous to life or limb, might be sufficient to disarrange or injure the machinery.

What now remains to be done is to study and develop the art of navigating the machine, but in order to do this it will be necessary to obtain larger premises free from trees and houses, and not until after it is possible to maneuver the machine within a few feet of the ground should high or free flight be attempted. I have the utmost confidence that with the expenditure of a little more time and money, every difficulty will be overcome.

I would like to say a few words in regard to the efficiency of screw propellers working in the air.

When I began to investigate the subject, I found that there were a great many opinions. Some engineers informed me that a screw propeller, on account of its fan blower action, would be very wasteful of energy, because it would draw in air at the center and discharge it at the periphery. Upon experimenting, however, I found that it drew in air at the periphery and discharged it to the rearward.

Some engineers were of the opinion that, in considering the screw thrust, the projected area of the screw blades should be considered as a normal plane being thrust through the air at the rate of the slip, while others were of the opinion that the whole screw disk should be considered, and that the thrust would be equal to pushing a normal plane, equal to the screw disk, through the air at the velocity of the slip. Others again were of the opinion that the thrust of the screw would be about 0.75 of such a normal plane.

The total area of my screw disks is very nearly 500 square feet, and the slip while running at 40 miles an hour is almost exactly 18 miles an hour. According to the first system of reasoning, in which only the projected area of the screw blades is considered, the thrust would be only 152 lb.; while if we considered the whole disk, it would be 810 lb., but, as a matter of fact, upon trying the experiment, I found the thrust to be 2,000 lb.

When the machine was fastened to the track, and the screws run at such a speed that the product of the pitch multiplied by the number of turns was equal to 68 miles an hour, it was found that the screw thrust was 2,100 lb.

If we consider the projected area of the screw blades as normal planes with the wind blowing against them at a velocity of 68 miles an hour, we have a pressure of 2,173 lb., which would seem to show that while the machine is standing still and all the energy goes into slip, that the first system of reasoning is correct, while the actual thrust when running depends altogether upon the speed; the higher the velocity, the less percentage of slip.

$$\begin{aligned} V^2 \times .005 &= P, \\ (18^2 \times .005 \times 94) &= 152.28 \\ (18^2 \times .005 \times 500) &= 810 \\ (68^2 \times .005 \times 94) &= 2173.28. \end{aligned}$$

DISCUSSION.

Sir Richard Webster, the chairman, having invited questions, Mr. Davis asked Mr. Maxim if he could explain the theory of a bird's flight? He thought it would be as well to investigate this question before any large amount of money was spent in experiments. It was generally a good plan to go to nature, but, so far as he understood, Mr. Maxim was endeavoring to fly in the same way that a fish swam in the water. There were screw propellers for going through the water, and the same principle seemed to be adopted in this flying machine; but he did not think a bird propelled itself through the air by means of its tail.

Mr. Jenkins asked how the machine was steered in a horizontal direction, and what would be the effect of tipping in going round a corner? It seemed to him that there would be a tendency to turn the machine over, and he should like to know if the side planes were capable of adjustment, so as to counteract that tendency.

Mr. Walter Reid asked what was the ultimate speed which it was hoped to attain by mechanical means. No doubt this was an important advance for military purposes, and he hardly knew whether they ought to wish Mr. Maxim success or not, because, if his machine

were successful, it looked as if it would bring our nearest neighbor within an hour's distance.

Mr. Lascelles-Scott said it seemed almost demonstrated, that it was possible by purely mechanical means to lift certain weights against the force of gravity and to enable the machine and its contents to rise in the air; but in view of some researches which he had been studying within the last six months, the researches of Mr. J. W. Keely, he was induced to believe that by the use of certain powers of mechanical and musical vibration it was possible to wholly or partially neutralize the force of gravity in various substances. It would be interesting to know what amount of speed Mr. Maxim thought he could attain as a matter of ordinary enterprise, say in passenger vessels, and, secondly, if it were possible to neutralize the weight of the machine by vibration upon the Keely system, what speed he would attain then.

Mr. Maxim said before he took up this question he thought something of the flight of birds and also something of terrestrial navigation. He had no doubt that if he turned his energies in that direction, he might succeed in making a locomotive which would imitate the action of a man walking, and go perhaps four miles an hour; but there were plenty of men living who could make locomotives to go 60 miles an hour. It would be as foolish to try to imitate the flight of a bird as to imitate the walking of an animal on the ground. In a flying machine it was necessary to have an enormous amount of power at disposal, to be delivered in a continuous manner and always in the same direction. In the wings of a bird the movements were exceedingly complicated, and to imitate them the number of articulated joints would be enormous. Anybody attempting it would find the superstructure necessary to attach all the levers to would weigh more than his machine. He did not know why the wheel for land locomotion and the screw for navigating the water or the drive were not all that could be expected. When you drove a dog cart along a street and had to turn the corner of a street, it was necessary to make an abrupt angle, but when you got above the trees and houses—if you once got there—you could take as large a sweep as you liked.

No doubt there would be a considerable amount of rolling, on account of currents of wind, and when the machine went round a circle, the greatest weight being below, the centrifugal action would throw it out, and that would bring the side wings automatically into the right position; it was not necessary to make them adjustable. With regard to the speed, he commenced modestly, and found that the lowest speed to which it was practical to lift the machine was 35 miles an hour; it was no use experimenting with a less speed than that, and everything considered, he thought from 60 to 65 miles an hour would be the most suitable speed. Whatever he did, he had no doubt that as the machines were developed, if a number of smart men like Thornycroft and Yarrow got hold of it after he had succeeded, they would very soon bring the speed up to 100 miles. Everything was in favor of high speed. The higher the speed the flatter the angle of the plane, and the greater the efficiency of the screw, because the screw was then working in undisturbed air, and the slip was not so large, relatively.

With regard to Keely's motor, he did not suppose there was any man in England who knew so much about it as himself. By a fortunate chain of circumstances he happened to find out all about it. It was suggested that some vibratory action would prevent the thing falling down; unfortunately, as far as flying was concerned, the force of gravity was a well-known fixed quantity; you could not change it or make it pull in the opposite direction. He had a great many people writing him letters making various suggestions; some had found a way of reversing the action of gravitation, and making it pull up; a good many had suggested running the machine with a turbine, and using the same water over and over again, using an electromotor—an electromotor in which the current should be taken from the dynamo back to the motor again; and others had an ingenious device of unbalanced water and spiral springs inclosed in a box, which pushed more in one direction than in another. He wished he could get a vibratory apparatus which would be useful, but he was very much afraid that if he put it on the scale he would find that a pound of steel would still weigh exactly 16 ounces.

Mr. Anson asked if Mr. Maxim thought he was the first who ever got a flying machine to rise.

Mr. Maxim said that many years ago a Frenchman named Penand succeeded in twisting a rubber spring, and making a thing somewhat like a butterfly, which went about 10 ft. in the air, flopped about, and fell down again; he presumed that was what the gentleman referred to. A good many experiments had been tried in various parts of the world, some in Russia, but he did not think they succeeded, and that the machine lifted itself. He thought Mr. Phillips, of Harrow, had done more than anyone else except himself in this direction. He was the only one who had experimented in a thoroughly scientific manner, and great credit was due to him. He made a machine with three wheels, which lifted two off the track, but his engines were not very perfect, and soon ran down; he did not make as much steam as he was using. But still he did prove something, and he did not know of any one else who had done as well.

Mr. H. C. Ahrensbeck said he must correct Mr. Maxim with regard to the Russian experiment. He supplied the engine, in 1880 or 1881, an illustration of which was given in Engineering on May 6, 1881, and it did rise.

Mr. Davis said his question as to how birds flew had not been answered, and he still thought it was material and important.

The chairman said the question might be interesting, but it hardly came within the scope of the paper. In proposing a vote of thanks to Mr. Maxim, he would say that he had heard a great many papers in that room, but he had never heard one which contained more information or was more admirably put together. What struck him first about it was the exhaustive nature of the inquiry made by Mr. Maxim; he might be right, or he might be wrong, but he had left nothing in doubt; he tried each step as he went forward. To adopt his own simile, in endeavoring to make a machine to walk in the air, he had tried every joint before he allowed it to make a single step. What made this paper such an important one was that Mr.

Maxim appeared to have solved the minor points of difficulty, at any rate, and make the ground secure, so that others might go forward with the benefit of his experience. The next thing was that he had combined in his experiments both science and practice. He had not been content with saying—This scientific theory ought to act; planes on this angle ought to succeed; or some other device should be tried; but he had endeavored to find out what the scientific theory of a flying machine should be, and then had shown, as far as he had gone, how to carry that scientific view into practice.

With regard to Mr. Davis' question, he might say that there was another very marked departure in Mr. Maxim's discoveries. Those who had read accounts of flying machines in days gone by, would remember that they started from one of two sides, either to fly with the wings of a bird, the earliest attempt, according to classical story, being more than 2,000 years ago, and this had been tried again within the last 30 or 40 years, and proved an utter failure; and the other method was to utilize the lifting power of a balloon. The first thing Mr. Maxim had demonstrated was, that he could, by the power of the machinery, lift the machine's own weight, and drive it forward through the air by its action on the air. He hoped all present had followed the proof—so far as it went—of this fact. The machine left the rails on which it was running and burst up the controlling rails, which should have kept it down. Whether or not he was the first to solve this problem, he did not care to consider. His own opinion of the paper might be of little value from a scientific point of view, but he would remind the meeting that when Mr. Maxim described his invention before the British Association at Oxford, two of the greatest scientific men now living, Lord Kelvin and Lord Rayleigh, then expressed the opinion that Mr. Maxim by his discoveries had established the fundamental principles of a flying machine. He was quite satisfied that though there might be critics present who thought that Mr. Maxim was over- sanguine, or that others had, to a certain extent, solved the same problems, they would all agree that this paper was eminently deserving of their warmest thanks.

The vote of thanks having been carried unanimously, Mr. Maxim said he was disappointed at not having more criticism. At the time he took up this subject it was almost considered a disgrace for anyone to think of it; it was quite out of the question, practically. But a good deal had been said in the public press, both in England and the United States, during the last three or four years, about it, and at least nine people out of ten were of opinion that it would be possible to construct a flying machine, at least for warlike purposes—for reconnoitering, carrying explosive bombs into an enemy's country, and so on. England had control of the sea, and if they all put their shoulders to the wheel, notwithstanding the French and Russians spent a great deal more money than had ever been spent here, she might be able to have control of the air also. As long as he remained in England he should not forget that he was an Anglo-Saxon, and should try to do as much for navigating the air as others had done for navigating the water. He had been a member of the Society of Arts for many years, but this was the first paper he had the honor of reading there. He hoped it would not be the last, and that at some future time he would be able to describe to them the sensations of aerial flight.

CART AND LOAD LIFTED.

NOVEL METHOD ADOPTED FOR FURNISHING FUEL TO THE ENGINE IN A STRUCTURE NOW BUILDING.

THE following is the way in which coal and materials are conveyed to the new twenty-three story building.



ing of the American Tract Society which is being erected at Spruce and Nassau Streets, New York. There is a shaft in the center of the building and at the top is a great hoisting derrick. The team that hauls a load up to the curbstone is unhitched and the tackle from the derrick is made fast to the wagon, which is straightway hoisted to the top of the building, and the arm of the derrick being swung around, it is lowered through the shaft to the spot where it is dumped.

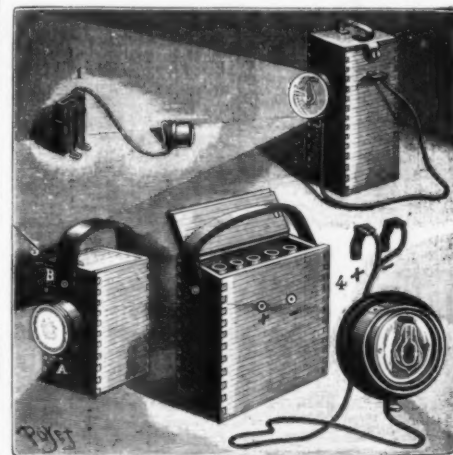
Then the operation is reversed, the wagon reaches the curb again, the horses are harnessed, and away they go. Thus, in five minutes, says the New York

World, is accomplished the work that it would take an hour and a force of men to do if the coal were carried to the engine by the barrel.

PORTABLE ACCUMULATORS.

AMATEURS have for a long time been looking for portable accumulators of small size and limited weight and capable of furnishing a sufficient quantity of electric energy. A large number of styles have been tried, but almost all of them have presented grave inconveniences. They have not been very portable, the acidulated water has escaped on every side, and the plates, during carriage, have broken and fallen into pieces at the bottom of the vessel. An English concern has just constructed a new apparatus called the Bristol portable accumulator, which seems to be free from such drawbacks.

In these accumulators the negative plates are formed of reduced spongy lead and are inclosed in a



PORTABLE ACCUMULATORS.

1. Model for bicycle lamps. 2. Portable lamp with three elements. 3. Model with an interrupter. 4. Model of five elements with independent lamp.

fabric of very porous asbestos. The positive plates consist of a paste of peroxide of lead compressed and held very tightly between two sheets of rubber. These latter contain a large number of apertures of small diameter. The positive and negative plates are separated from each other at a distance of 0.35 of an inch by wooden wedges. The liquid is water acidulated with sulphuric acid.

The plates are placed in an ebonite box, and the latter is coated with a paraffine varnish that leaves apertures only for the disengagement of the gases during the charging. These apertures can afterward be closed.

Several models of apparatus have been established with these accumulators. The accompanying figure represents a few of these. At 1 is seen the model for bicycles, which consists of a small box from 4½ to 6 inches in length and 1 inch in thickness. It contains three elements, can furnish a capacity of 3.5 ampere hours with a discharge of 0.6 ampere and weighs about 18 ounces. The charge should be effected with a difference of potential of 7.25 volts and an intensity of 0.35 ampere. A double, flexible wire, mounted upon a collector that establishes the contacts with the battery, supplies a lamp of about 1.5 candle. This is placed in a small lantern that can be easily hooked to the bicycle. This lamp is of feeble consumption and is capable of giving a light from five to six hours with one charge of the battery.

Fig. 2 represents a model of a battery of three accumulators contained in a box upon the front of which is fixed the lamp provided with a reflector. At the side is the collector, which is connected with the terminals within. Fig. 3 shows another model in which the lamp can be lighted or extinguished by means of an interrupter, which may be seen at A. When the lamp is extinguished, the interrupter uncovers an aperture, into which is introduced the wire for effecting the charge. At B is placed the positive wire. These different models may be constructed with a variable number of elements, and with a capacity likewise more or less elevated, according to the weight. It has thus been possible to reach differences of potential of from 10 to 12 volts and capacities of 66 ampere hours. Fig. 4 represents a model of five elements, with the lamp in the reflector at the side.

As may be seen, the new Bristol accumulator is a very practical apparatus that might be utilized for the lighting of carriages, street cars, bicycles, etc. It might, if occasion demanded, replace batteries in a large number of applications necessitating a feeble quantity of electric energy. There is one difficulty that presents itself, and that is relative to the charging; but, as far as Paris is concerned, there is a movement on foot at this moment to install some small stations whither one might go to have the battery recharged at a trifling expense. The Bristol may therefore prove useful under many circumstances.—La Nature.

ELECTRICITY ON BOARD SHIP.*

By ALFRED H. GIBBINGS.

THE author divided into two classes auxiliary machinery to which electricity has been applied as a motive power:

1. Those which have been specially designed for use on board ship.
2. Those which have been proved practically successful for land purposes, and which could readily be adapted for use on board ships.

* Read before the Hull and District Institute of Engineers and Naval Architects, on November 5, 1894.

In the first list may be classed electric winches, electric cranes, electric steering gear, electric capstans, electric fans.

In the second list may be classed electrically driven lathes, electric drills, electric refrigerators, electric pumps, electric ash hoists, etc.

ELECTRIC WINCHES AND CRANES.

In the Royal Naval Exhibition of 1891, Messrs. Siemens Brothers exhibited an electric winch capable of lifting 5½ tons at the rate of 100 feet per minute, with an expenditure of \$5,000 watts. Three sizes are made by this firm, which lift respectively 1½, 3, and 5½ tons, at a speed of from 90 feet to 100 feet per minute. The winch is complete upon a cast iron bed plate, and is driven in either direction by a motor placed in a watertight metal cover. It is of the horse-shoe type, with armature above the electro-magnets—the base plate of the winch forming in part the yoke piece. The controlling lever is to the right of the operator, and actuates an electrical switch which is inclosed in a watertight box fixed to the frame of the winch. When the lever is in middle position no current passes through the motor, but by moving it in the one direction or the other, that is, away from or toward the attendant, the motor revolves in corresponding directions, its speed being regulated by the angle through which the lever is turned.

The motor is geared to the winch by means of helical gearing, and a quick motion is provided for light work, to secure which the lever in the center of the winch is provided, so that by moving it to the right or left the necessary alteration is made in the gearing of the winch. A foot lever is placed in a convenient position, and is in connection with the brake on the barrel shaft in the usual manner.

Messrs. Crompton & Co., of Chelmsford, also make a similar electric winch, and for the last two years one of their electric cranes has been in successful operation in a large timber yard in Limehouse, in the East End of London. An electro-motor is attached to the frame of the crane and geared with friction gearing to a central shaft, which, by means of three levers and a foot brake, performs the three operations of hoisting, slewing and propelling the crane. The power is derived from an 18 unit Crompton dynamo, which also supplies 300 incandescent lamps employed for lighting one of the factories. The crane motor will lift 18 cwt. at a speed of about 80 feet per minute at an expenditure of 3,300 watts.

The following tabulation will give an idea of the cost, etc., of electric winches and cranes designed for use on board ship:

	E. H. P.	Two tons raised per minute in feet.	Cost.
Electric winch.....	15	40	£135
Electric crane.....	35	70	230

ELECTRIC STEERING GEAR.

On January 26, 1893, a complete specification was filed by Messrs. Siemens Bros. for an electrical steering apparatus, the provisional specification being No. 8,268, dated May 2, 1892.

SIEMENS' ELECTRICAL DRILL.

This apparatus is arranged in a compact and portable form, so that it can be readily applied in any position for drilling holes in iron or steel plates.

The frame consists of two parallel soft iron side bars, connected together by a transverse bar of soft iron at an intermediate part of their length, and connected at the end by a non-magnetic casting.

On the intermediate bar are mounted two bobbins, which serve two purposes when excited by an electric current. 1. The free ends of the bars are made to constitute a pair of electro-magnetic poles, so that when these ends are placed against the iron or steel plate to be drilled, the plate closing the magnetic circuit causes the drill frame to adhere to the plate. 2. Near the other end of the iron bars are attached arc-shaped pole pieces forming another pair of poles and between these a ring armature is mounted on a central hollow axis, parallel with the side bars, through which axis the drill spindle passes. The whole of the working parts are inclosed within a strong casing, which also forms a bearing for the drill spindle. Very compact and efficient arrangements are made for "feeding" the drill, the whole apparatus being designed so as to be slung by any suitable tackle.

The advantages of this arrangement over the usual method of rigging up a swan neck and using a ratchet drill are obvious, and much time might be saved by its use when doing these necessary repairs, in the few hours available when calling at the various ports en route.

ELECTRIC CAPSTANS.

An electric capstan is also made by Messrs. Siemens Bros. It is mounted upon a cast iron base plate, and protected by a strong metal cover, which is supplied in places with watertight doors, for oiling, etc. The internal arrangement of the motor and gearing is very similar to that of the winch. The motor is controlled by means of a lever, in connection with an electric switch inside the capstan.

Messrs. Crompton & Co. also make an electric capstan, the gearing of which is different to that of Siemens'. The advantage of the one form over the other will depend upon the power and speed required.

ELECTRIC FANS.

A very successful electric light installation has just been fitted up by Messrs. J. H. Holmes & Co., of Newcastle-on-Tyne, in the steamship Petersburg, belonging to the Russian Volunteer Fleet, and built by Messrs. Hawthorn, Leslie & Co., Limited. Messrs. Holmes also fitted in the vessel five fans adapted to the purpose of ventilating the ship. Two of those fans were 3 feet in diameter, two of them 2 feet in diameter, and one 18 inches.

All the motors were of the same size, but ran at different speeds, and they were specially designed by Messrs. Holmes & Co. to work with the axis vertically at the bottom of the ventilating cowls.

The peculiarities of the motor are, as you will notice, that the armature is overhung, there being only one bearing. The horseshoe magnet is placed at right

angles to the ordinary position, so as to obstruct the passage to the air as little as possible.

The brushes are made of carbon, and both magnet coils and the armature are carefully covered up, so as to be practically waterproof. The upper part of the motor, including the commutator, is further protected by a brass cover, fixed by wing nuts.

With regard to the power necessary for ventilating purposes, of course, this depends upon the length of the tubes for passages, along which the air has to be moved. From experiments made on this vessel, the following results were obtained:

Size of fan. Feet.	Revolutions per minute.	Cubic feet per minute.	Watts.
3	700	5,000	960
2	1,000	2,000	550
1½	1,230	1,400	480

Messrs. J. H. Holmes & Co. have also fitted up with electric fans the steam yacht *Namouna*, belonging to James Gordon Bennett, Esq., and also the steamships *Origen* and *Hubert*, belonging to the Eoth Steamship Company, Liverpool.

CONVERTING STEAM INTO ELECTRIC WINCHES.

An experiment is about to be carried out in Hull with electric winches, on one of Messrs. Wilson's boats.

As an experiment between Mr. Spear and Messrs. Crompton, a departure from adopting the special designs of electric winches has been made, inasmuch as they are going to convert an ordinary winch fitted with steam power into one driven by electricity; substituting the steam engine portion by an electro-motor. This is a point of economy, as, of course, to discard an entire arrangement would be an expensive matter, and where a large portion of the machinery is not required to be altered, there is no necessity, in the case of existing vessels, to make an entire replacement.

ADVANTAGES OF ELECTRIC MOTIVE POWER.

The most important advantages, however, of electric motive power may be considered under two headings, viz.: Motors v. steam engines, cables v. steam pipes.

The advantages under the first heading are as follows:

1. Greater facilities in starting, stopping, and reversing, consequent on a rotary instead of a reciprocating motion, and obviating the evil effects of condensed water in steam cylinders, etc.

2. No leaky drain cocks, defective stuffing boxes, or glands.

3. Noise in working is reduced to a minimum, which is a matter of considerable importance in passenger vessels, where cargo is loaded and unloaded at night, and where the cranes and winches are frequently in proximity to cabins.

4. Less coal per brake h. p., due to the higher efficiency of an electric motor as a converter of energy, taking into consideration only the diminished losses of power in working one large instead of several small steam engines.

5. Less room is occupied by the motor than by the steam or hydraulic engines, and in the case of electric cranes, by leaving a clear space in front of the operator, the guidance and direction of the crane can be more readily and safely effected.

The advantages due to the use of electric cables in the place of steam pipes are:

1. The disadvantages of leaky steam joints are avoided.

2. Less space is occupied and greater facility in fixing is obtained. Steam pipes are always more or less unsightly and inconvenient, and especially so when they pass through cabins and alleyways. When they are carried on the surface of the deck and have to be protected by large iron casings or coverings, they are a distinct source of danger to passengers and crew. On the other hand, electric cables can be carried the whole way on the underside of the deck or on the face of bulkheads, and the deck is thus left free and clear on the surface.

3. Electric cables can be bent to suit any angle.

4. No heat or any other unpleasant effects are experienced with electric cables.

5. No corrosion and no alternate expansion and contraction occurs as with copper steam pipes.

6. No loss of power as with condensation of steam in pipes.

The loss of power in electric cables where the current does not exceed 500 amperes per square inch of section may be stated to be, on a 65 volt circuit, 1 per cent. of the total energy transmitted per 100 yards. This loss, moreover, is directly proportional to the length, which is hardly true of the loss of steam transmitted in pipes, such loss becoming greater in proportion after a certain distance from the boilers. A 1½ inch copper steam pipe covered to a thickness of 1 inch all round with woolen felt loses by radiation 73 thermal units per foot run per hour at a boiler steam pressure of 120 lb. The loss, therefore, for 50 feet will be 3,650 thermal units or 1½ horse power per hour, which is a very large factor in the case of the small engines required for auxiliary machinery. It will be within the mark to estimate this power loss from 10 per cent. to 20 per cent.

The author concluded by saying that many of the supposed drawbacks and objections to the use of electrical machinery on board ship are to a great extent imaginary, and the difficulties disappear with good installation work and careful attention.

ATOMIC VOLUMES.

By C. T. BLANCHARD, M.A.

SINCE Prof. Lothar Meyer's work on atomic volumes there have been no tables of these important physical properties constructed to harmonize with the most recent or best authenticated values for both atomic weight and specific gravity. I subjoin a table so constructed for the elements, placing the hitherto received values, according to Lothar Meyer, in the last column, $O = 16$. The specific gravity is taken at $0^{\circ} C$.

From these tables the following laws can be deduced:

Group.	Element.	W.	D.	W D	Old value	Authorities.
I.	Lithium.....	7.03	0.59	11.9	12	Stas; Bunsen.
	Sodium.....	23.05	0.97	23.8	24	Stas; Gay-Lussac and Thenard.
	Potassium.....	39.136	0.87	44.9	45	Stas; Gay-Lussac and Thenard.
	Rubidium.....	85.48	1.52	56.4	56	Godefroy; Bunsen.
	Cesium.....	132.99	1.88	70.7	70	Bunsen; Stetterberg.
Ia.	Copper.....	63.604	8.94	7.0	8	Richards; various.
	Silver.....	107.93	10.53	10.35	10	Stas; Rose.
	Gold.....	197.16	19.33	10.20	10	Kruss; Rose.
II.	Beryllium.....	9.1	1.85	4.9	6	Nilson and Pettersson; Humpidge.
	Magnesium.....	24.287	1.74	13.9	14	Burton and Vorce; Bunsen.
	Calcium.....	40.00	1.57	25.6	25	Erdmann and Marchand; Matthiessen.
II.	Strontium.....	87.6	2.54	33.9	34	Dumas; Matthiessen.
	Barium.....	137.0	3.75	36.5	36	Dumas; Kern.
IIa.	Zinc.....	65.34	7.10	9.2	10	Gladstone and Hibbert; Rammelsberg.
	Cadmium.....	111.802	8.55	13.0	13	Partridge, Clarke; Schroder.
	Mercury.....	200.36	13.596	14.7	14	Erdmann and Marchand; Regnault.
IIb.	Iron.....	56.00	7.86	7.1	7	Erdmann and Marchand; various.
	Ruthenium.....	101.66	12.63	8.05	8	Joly.
	Osmium.....	191.18	22.48	8.50	8	Seubert; Deville, Joly and Vezes.
III.	Boron.....	10.825	2.5?	4.13	4	Abraham; Hampé.
	Aluminum.....	27.08	2.6	10.4	11	Mallet; Deville, Heeren.
	Scandium.....	44.09	?	?	?	Nilson.
	Yttrium.....	89.02	?	?	?	Cleve.
	Lanthanum.....	138.2	6.1	22.6	22	Bettendorff, Brauner; Hillebrand and Norton.
IIIa.	Gallium.....	69.9	5.95	11.8	12	Boisbaudran.
	Indium.....	113.68	7.42	15.3	14	Bunsen; Winkler.
	Thallium.....	204.146	11.85	17.2	17	Crookes; De la Rive.
IV.	Carbon (ad.).....	12.003	3.518	3.41	3	Roscoe; v. Baumhauer.
	Silicon (ad.).....	28.4	2.39	11.8	11	Thorpe and Young; Winkler.
	Titanium.....	48.13	?	?	?	Thorpe.
	Zirconium.....	90.63	4.15?	21.8?	21	Bailey; Troost.
	Cerium.....	140.22	6.65	21.09	21	Brauner; Hillebrand and Norton.
	Thorium.....	232.4	11.0	21.13	?	Nilson and Kruss.
IVa.	Germanium.....	72.32	5.469	13.2	?	Winkler.
	Tin.....	118.08	7.29	16.2	16	Van der Plaats; Matthiessen.
	Lead.....	206.9	11.352	18.2	18	Stas; Reich.
IVb.	Cobalt.....	58.80	8.6?	6.80	6	Zimmermann; Rammelsberg.
	Rhodium.....	102.96	12.1?	8.50	8	Seubert and Kobbe; Deville and Debray.
	Iridium.....	193.18	22.42	8.97	8	Seubert, Joly; Deville and Debray.
V.	Nitrogen.....	14.041	0.90	15.6	?	Stas; Wroblewski.
	Phosphorus (red.).....	31.025	2.2	14.1	13	Schrotter; Hittorf.
	Arsenic (am.).....	74.97	4.71	15.9	13	Dumas; Bettendorff.
	Antimony.....	119.96	6.697	17.9	18	Cooke; Schroder.
	Bismuth.....	208.6	9.75	21.4	21	Marignac; Classen, Schroder.
Va.	Vanadium.....	51.21	5.5	9.31	9	Roscoe.
	Niobium.....	94.20	7.06	13.3	14	Marignac; Roscoe.
	Tantalum.....	182.8	10.4	17.6	16	Marignac; Roscoe.
VI.	Oxygen.....	16	1.13	14.3	?	Berzelius; Olszewski.
	Sulphur (rhomb.).....	32.0626	2.075	15.45	15	Stas; Pisati.
	Selenium (cryst.).....	79.070	4.5	17.57	17	Pettersson and Eckmann; Rammelsberg.
	Tellurium (cryst.).....	124.85	6.246	19.99	20	Brauner; Priwosnik.
VIa.	Chromium.....	52.14	6.73	7.45	8	Rawson, Meinecke; Glatzel.
	Molybdenum.....	96.08	8.6?	11.17?	11	L. Meyer; Debray.
	Uranium.....	239.4	18.7	12.70	13	Zimmermann.
VIIb.	Nickel.....	58.1	8.9	6.53	6	Kruss and Schmidt; Schroder.
	Palladium.....	106.56	12.148	8.77	9	Keiser; Lowry.
	Platinum.....	194.83	21.5	9.06	9	Seubert; Deville and Debray.
VIIc.	Erbium.....	166	?	?	?	Cleve.
	Tungsten.....	184.08	18.77	9.83	10	Roscoe, Waddell; Waddell.
VII.	Fluorine.....	19.01	?	?	?	Dumas, Christensen, Moissan.
	Chlorine.....	35.45	1.46	24.3	25	Stas; Knietseh.
	Bromine.....	79.96	3.187	25.0	26	Stas; Pierre, Quincke, Van der Plaats.
	Iodine.....	126.86	4.95	25.6	25	Stas, Cooke, Gay-Lussac.
VIIa.	Manganese.....	55.1	7.39	7.45	6	Dewar and Scott, Marignac; Glatzel.

* The boron contains a trace of aluminum.

† The value of D for liquid nitrogen is probably too low; if taken as $\frac{1}{11}$ that of oxygen—and the boiling points are almost the same—it becomes 0.98, giving a concordant atomic volume of 14.3.

—Chemical News.

1. In the metallic groups, I. and II., the atomic volumes vary most.

2. In the intermediate groups, III. and IV., and the a groups, the atomic volumes vary but little.

3. In the nonmetallic groups, V., VI. and VII., and the b groups, the atomic volumes vary least, approaching a constant for each group.

IMPROVED FLAT IMAGE LENSES.

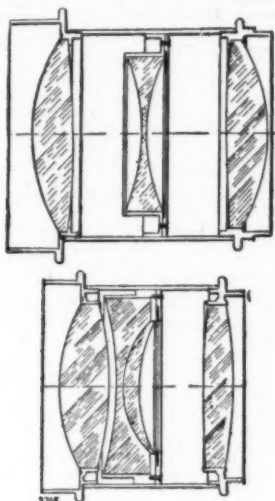
MESSRS. COOKE, of York, have recently produced a very ingenious form of objective, intended for cameras and lanterns, which Engineering describes as follows:

If one takes an ordinary meniscus lens, then rays of light coming from a distant point, and parallel to the axis of the lens, are brought accurately to a focus in the axis of the lens. This is not the case, however, with other rays also coming from a distant point, but passing through the lens obliquely. Such rays are not brought accurately to a focus in any single point. By using stops, however, it is possible to shut off a number of the marginal rays, and then the remainder passing through the aperture of the stops are brought fairly well to focus on the screen of the camera. But as some of the marginal rays are thus stopped off, the brightness of the image at the edges of the plate is considerably less than in the center; and, moreover, the image at the edge of the plate is also not quite so accurately in focus, each point of light in the object being, in fact, represented by a small balloon shaped disk. It is, however, possible to make a lens of such a form that any pencil of rays coming from a distant point is brought accurately to a focus, whether it passes through the lens normally or obliquely. When such a lens is used, however, the surface on which the foci of the different pencils lie is not flat, as is required for photographic purposes, but curved, being approximately a portion of a sphere. Those of our readers

who have entered a large camera obscura, such as that at the Crystal Palace, will remember that the screen takes the shape of a hollow disk. Hence, though such a lens gives nearly even illumination, and very accurate focusing over the whole area of the screen, it is useless for photographic purposes, where it is essential that the image shall be received on a flat surface. If a double concave lens is placed behind a lens of the type just described, it will tend to flatten the image, and Messrs. Cooke have discovered that it is possible to entirely flatten the image in this way. It might be thought that to do this it would be necessary to use a negative lens of such power that it renders the rays it receives from the convex lens parallel again, and therefore they would not be brought to focus at all. This, however, is not the case, and Messrs. Cooke's new lens is a realization of this fact. For practical reasons the convex portion of the above combination is split into two parts, and the concave lens is placed between them. By the use of suitably chosen glass it is possible to calculate the curves of the various lenses and their distances apart, so that the center lens, at the same time that it renders the image flat, also renders the whole combination achromatic. Each of the three lenses of the combination then consists of a single piece of glass, and is not separately achromatic. Each lens of a good ordinary doublet or triplet lens has to be separately achromatic, and hence in an ordinary doublet lens there are eight surfaces to grind and polish, and in a triplet twelve. In the new lens there are but six such surfaces, while its performance is claimed to be at least equal to the very best of existing lenses.

Two varieties of the lens are shown. The upper form is intended for portrait work, and with an aperture of f —it gives a flat and very good image over the

whole of a plate the longer side of which is equal to one-half the focal length. The positive lenses in this case are both made of borosilicate crown glass, while the negative lens is of light silicate flint glass. The lens shown is intended for hand camera work



and lantern work, as well as copying and enlarging.

With an aperture of $\frac{F}{5.65}$ it gives a well defined flat image

upto the corners of a plate the longer side of which is four-fifths of the focal length; and when stopped

down to $\frac{F}{8}$, it covers a plate whose longer side is equal

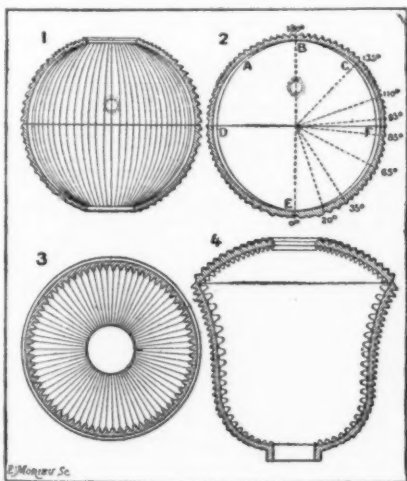
to the focal length, the illumination in both cases being remarkably even. The two positive lenses are the same as in the previous case, but the negative lens is, it will be seen, compound, the front portion being made of a silicate glass, and the back component of baryta crown glass.

HOLOPHANE GLOBES.

VARIOUS forms of electric light globes have been in use since the invention of that light. They have been usually of two kinds—either made of clear glass or opal glass. In the globes made of clear glass the intense light of the arc is unpleasant to the eyes, and in the opal globes the loss by absorption is 40 to 60 per cent.

To avoid these considerable losses, it is necessary to construct a globe which permits of utilizing certain optical properties of glass which allow of diffusing the light in all directions, or to concentrate it in certain directions. Such globes are made by the Societe Francaise d'Eclairage Holophane. This firm manufactures a variety of globes, which are known as "holophane" globes. The globes are largely used in the lighting of Paris, on the grand boulevards, from the Rue d'Hotelville to the Boulevard Sebastopol. The holophane globes, as their name would imply, appear to diffuse the light over the entire surface, or it can be concentrated. These peculiar properties have been obtained by the use of grooves on the spherical or ovoid globes, by the use of a special glass and by the peculiar construction of the grooves, both on the exterior and in the interior of the globe.

The exterior grooves are formed by the combination of two surfaces, one reflecting, the other refracting, which have been calculated mathematically to produce the required effect. Some are made with salient angles, others with mixed profiles, each composed of two parts alternately refracting and reflecting. Figs. 1 and 2 represent vertical sections of one of the globes, and Fig. 3 the horizontal section. The interior grooves



HOLOPHANE GLOBES FOR LIGHTS.

1 and 2. Vertical and horizontal sections of a globe for diffusing light. 3. Vertical section of a globe arranged to concentrate the light by reflecting it downward. 4. Vertical section of a tulip globe with a reflecting cover.

are arranged like meridians of longitude, and the exterior grooves like parallels of latitude. The globes are made by pressing, each half being made separately. The two halves are fastened together either with a metallic band, or they are held together by a wire

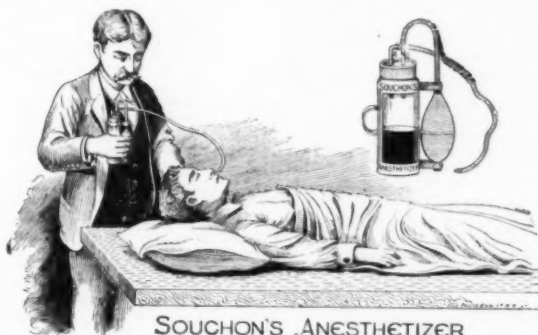
net. The globe shown in Fig. 1 is simply for diffusing light, and spreads out in all directions. Fig. 2 represents a globe arranged for concentrating the light downward. To attain this end the upper part, A, B, C, is formed of reflecting grooves, and in the other part, D, E, F, the grooves are mixed. Fig. 4 is a vertical section of a tulip globe, having a reflecting top. Fig. 5 is a spherical holophane globe. Fig. 6 is an open holophane globe, applicable to any source of illumination. Fig. 7 is a holophane cone, which may also be applied to almost any source of illumination. With an ordinary gas burner, or the Welsbach light, it is remarkable to notice the difference in the illuminating power of the light when the new globes are applied. By actual photometric tests it is found that the absorption is only from 9 to 13 per cent.

For our engravings and for the foregoing particulars we are indebted to La Nature.

A NEW APPARATUS FOR ADMINISTERING ANESTHETICS.

THIS new apparatus, by Dr. Edmond Souchon, of New Orleans, La., has for its object to force the vapor alone of anesthetics into the pharynx through a tube passed into the nose or mouth, or to force the vapor into a cone.

The apparatus consists of a receptacle or bottle of suitable size with a stopper traversed by two tubes,



an inlet and an outlet tube, neither of which dips into the liquid anesthetic, but stop close to the stopper. The two tubes are of the same diameter throughout and at both extremities, about one-quarter of an inch more or less. Stop cocks may be fitted to them to prevent the spilling or the evaporation of the anesthetic when the apparatus is not used. The inlet tube is connected with a compressible bulb which is fixed at both ends to the receptacle by a simple metallic frame, so that the apparatus can be readily held and worked with one hand, leaving the other hand free to take care of the pulse. A ring adapted to the frame on the side opposite to the bulb, and through which a finger is passed, assists in the working. A hook with or without a chain may be adapted to the frame so as to hook the apparatus to the vest or coat, as is used in some inhalers. The outlet tube from the stopper is provided with a rubber tube of suitable length which is connected with a cone, or is introduced through the nose or through the mouth into the pharynx.

The receptacle or bottle is filled or emptied by simply removing the cork.

To guard against any possibility of forcing the liquid anesthetic through the outlet tube, and also to guard against any spilling, so as to enable the anesthetist to lay the bottle on the bed or table without any apprehensions as to the consequences, it may be well to fill loosely the bottle with sufficient absorbent cotton to imbibe and hold the anesthetic; a sponge or any absorbent material will do as well. This, however, may diminish somewhat the strength or quantity of the vapor at each pressure of the bulb. After the operation is over the anesthetic unused keeps in the bottle and cotton as well as in a separate bottle, provided the tubes are disconnected and the holes plugged tightly.

The bulb is detachable and can be renewed whenever this becomes necessary.

The advantages of this apparatus over inhalers of

bottle is laid on the side or inverted; 3, in the fixation of the bulb at both ends, making the fastening of the bulb more secure and the bulb more easy to work with the same hand that holds the apparatus; 4, the ring which assists in holding it; 5, its small size, about five inches in height by two in diameter; 6, its cheapness; 7, the facility with which one can be constructed ad hoc; 8, the thorough manner in which it does its work; 9, the impossibility of its getting out of order.

Without such an efficient and simple apparatus it is impossible to make a daily practical success of maintaining the anesthesia through the nose or mouth in all operations on the face or its orifices, when otherwise the cone or wire mask has to be removed every few minutes to uncover the field of the operation to enable the operator to proceed with the operation. Soon after the inhaler is removed, the patient recovers from the effects of the anesthetic and the operator has to stop operating to allow the cone or mask to be applied over the face. With this anesthetizer, anesthesia is maintained uninterruptedly.

It is a great saving of time, pain, bleeding and shock to the patient, thereby contributing materially to the saving of life in operations which for the most part are long and bloody and often bring the patient to death's door. It is also a great saving of mental strain to the surgeon, who can proceed rapidly and uninterruptedly with the operation.

The nasal tube should be introduced down into the lower pharynx, otherwise the patient breathing through the mouth may not inhale sufficiently of the anesthetic. By compressing the bulb at the outset of an inspiration is best; this rule compels a closer watch over the respiration. By compressing the bulb more or less rapidly and thoroughly, the amount of the anesthetic is regulated; this must be borne in mind, lest too much anesthetic be given. It does not require much anesthetic to maintain the anesthesia after the patient has been well anesthetized. Any soft tube of whatever material will perhaps answer, but an ordinary soft red rubber catheter is the best, and is easily obtainable; this tube should be as large as the nasal cavity will admit. It is also important that all connections should be air tight for obvious reasons. Care should be taken that no bends or kinks form on any part of the tubes, as this will interfere with the proper working of the apparatus.

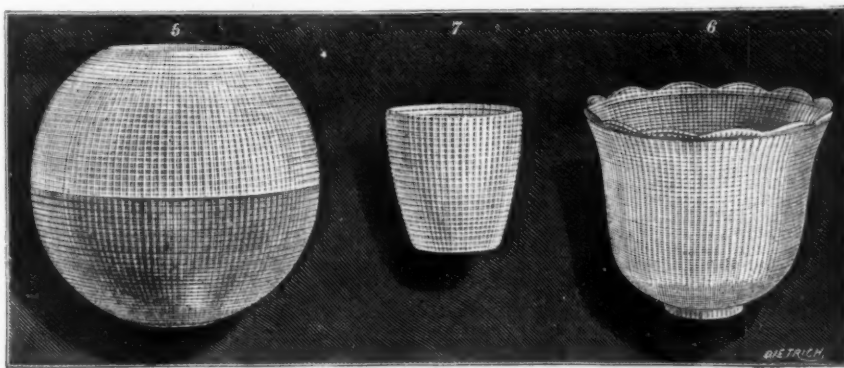
The one who administers the anesthetic can place himself in any position where he will be best out of the way of the operator, even at the head of the table or sitting, without interfering with the proper working of the apparatus.

Dr. Souchon applied for a patent to test the originality of the invention, but waives all his right and privileges as far as medical uses are concerned. G. S. Geo. Tiemann & Co. are the manufacturers.

THE POSSIBILITY OF LIFE IN OTHER WORLDS.

By Sir ROBERT BALL.

NOTWITHSTANDING the wonderful advances in scientific methods which have been effected in recent years, a great problem still remains unsolved. We are still as far as ever from having attained any definite answer to the question as to whether life can exist on any of the other worlds. Vast as has been the progress in



EXTERNAL APPEARANCE OF HOLOPHANE GLOBES.

5. Spherical globe. 6. Tulip globe. 7. Conical form of globe.

a more or less similar kind, consist: 1, in that neither the inlet or the outlet tubes dip down into the liquid anesthetic or come near to it, thus preventing the liquid anesthetic from being driven into the outlet tube, thence into the face or pharynx; 2, the absorbent cotton prevents also against this same accident and against the spilling of the anesthetic when the

knowledge since the days when Whewell and Brewster discussed the question of possible inhabitants in other planets, a writer in the present day finds the problem which they attempted still hopelessly beyond his reach, in so far as any determinate conclusions are concerned.

But it seems worth while to take up the question

afresh, inasmuch as some of the old arguments have acquired increased significance in consequence of later discoveries, while others are now seen to have lost something from the same cause. I propose, accordingly, to set forth some account of the present state of the argument, and to note whatever additional importance it may have acquired since the days when the habitability of other worlds was discussed by Brewster.

The standard argument in support of the belief that certain other planets might be inhabited was of this kind. It was noticed that the sun lies at the center of a system of bodies which revolve around it, and that among these bodies the earth holds an intermediate place. It is nearer to the central luminary than are some of the other planets, while, on the other hand, it is more remote than others. The warmth and light received by the earth from the sun would therefore be greater than that received by some planets, and less than that received by others. If some of the planets are much larger than the earth, then it must be remembered that other members of the same system are smaller than our globe, and that some of them are very much smaller. It was also pointed out that the earth in another respect is, as it were, a fair average specimen of a planet. Some of these bodies have moons revolving around them. It is quite true that Jupiter, Saturn, and Uranus are more richly endowed with attendant globes than is the earth; but then Mercury and Venus appear to be unprovided with any moons. It was thus seen that in the matter of satellites, as well as in dimensions and in situation, our globe is an intermediate one in the system. This conclusion was confirmed by the subsequent discovery that Mars had a pair of satellites and Neptune a single one. Indeed, the claims of the earth to be a typical planet might be pushed still further. A notable characteristic of a planetary globe is its density, that is to say, its weight in comparison with the weight of a globe of water of equal dimensions. Here again our earth appears in the light of a fairly representative object. It is much lighter, no doubt, bulk for bulk, than some of the other planets. It is, on the other hand, much heavier than others.

It is also noticeable in this connection, that our globe is surrounded with a copious atmosphere, and this is an attribute which of course stands in an obvious and specially important relation to the question of the earth as an abode of life. Those who pondered on the possibility of life on other worlds could not fail to be struck by the fact that some of those other worlds were also surrounded by atmospheres. If these atmospheres, in certain cases, were excessively dense and abundant, and in others greatly attenuated, this circumstance alone would tend once again to illustrate the intermediate rank, so to speak, of our earth as a member of the planetary system.

The argument then ran in this wise. Regarding our earth as a globe which constitutes a member of the solar system, it can hardly be said to possess very extreme attributes. It does not appear to be marked out in any specially distinctive manner which would qualify it rather than certain of the other globes for becoming suitable abodes for life. The qualities which the earth possesses are, generally speaking, conferred upon it in degrees intermediate to those in which other globes of the system are endowed with similar qualities. As the earth was inhabited, it would seem only reasonable to assume that in this respect also it was not exceptional, and that in all probability the other globes, some of them, or many of them, were also fitted for the abode of life, suitably adapted to the conditions which each globe had to offer.

Such was in outline the famous argument which was presented half a century ago, in support of the conclusion that in all probability certain other planets besides our earth contained organic life. It is worth while to see how far the present state of our knowledge affects the validity of this argument. That it does so cannot be questioned. I believe, on the whole, the argument has been strengthened by modern research, though it must be admitted that in some respects its efficiency has been impaired.

We can indeed, in these present days, bring forward a striking point of relationship between the earth and the other planets, as to which the earlier writers had no information. Had they been aware of it, they would certainly have regarded it as greatly strengthening the contention that it was reasonable to presume that the planets must be inhabited. But in those days, philosophers had little notion that so astonishing a fact would ever be demonstrated as that the material constituents of the earth were in a great measure identical with the materials constituting the sun. They did not know that the elementary bodies in the earth were substantially the same as the elementary bodies which make up the mass of the great luminary. It is, no doubt, quite true that we are not as yet able to affirm, with any absolute certainty, that the materials from which the planets, such as Venus or Mars, have been built are actually the same kind of materials as those which make up the earth. Our knowledge indeed stops short of this point. We can pronounce on the substantial identity of the solar materials with the terrestrial materials, because in the former case the bodies are so greatly heated that they are in the gaseous state. Spectroscopic methods are therefore available for determining their identity with the glowing vapors of the same substances as we have them on the earth. But the planets are not incandescent. Our spectroscopes may indeed, to some slight extent, inform us as to the constituents of the planetary atmospheres, but the actual solid portions of the planets cannot be analyzed by any means at our disposal. There is, however, no reason to think that the elements of which the planets are composed differ considerably from the elements of which the earth is made. For most astronomers now admit that the sun and the planets have had a common origin from some primitive nebula, and as we verify this theory by showing that the earth and the sun are substantially of the same constituents, it seems impossible to doubt that the substances which form the earth are largely, if not wholly, the same as the substances out of which the planetary globes have been fashioned. A striking confirmation of this doctrine of material uniformity is presented by certain of the comets which belong to the solar system. It is quite true that such objects have, so far as physical condition goes, no resemblance to

planets: it is, however, sufficiently remarkable that comets appear to be composed of materials resembling those of which our earth has been made. For these bodies happen to be, in part at least, of such a gaseous nature that we are enabled to submit them to spectroscopic analysis. They have thus been proved to contain some of the most important terrestrial elements.

It is therefore plain that the ancient argument in support of the notion that some of the planets might be tenanted with life can be considerably re-enforced by modern discoveries. For it may now be regarded as practically certain that various elements known on this earth are present in the planetary bodies. We thus see that the components necessary for the physical framework of living creatures, may in all probability, be as abundantly provided upon some of the other planets as they are on the earth.

In this connection it is instructive to bear in mind what is known as to the distribution of those particular elements in space which appear to be most characteristically associated with the manifestation of life. No result of spectroscopic research among the heavenly bodies has been more remarkable than that which demonstrates the extraordinary abundance with which the element hydrogen is diffused throughout the universe. It is of course one of the commonest elements of the earth, entering, as it does, into the composition of every drop of water. Hydrogen is also a constituent part of a vast number of solid bodies, but the remarkable circumstance for our present purpose is that this same element is found in profusion elsewhere. Surrounding that visual glowing globe of the sun there is an invisible atmosphere, of which hydrogen is one of the most prominent components. A like conclusion is drawn from the spectra of many of the stars. In the case of certain specially white and brilliant gems, of which Sirius and Vega may be taken as the types, the chief spectroscopic feature is the extraordinary abundance in which hydrogen is present. Even in the dim and distant nebulae gaseous hydrogen is the constituent more easily recognized than any other which they may possess. Indeed, it may be affirmed that we do not know any other substance which is so widely diffused as hydrogen. It need hardly be said that this gas is an important constituent in those compound bodies with which life is associated. In that somewhat greivous exhibition which shows the actual quantities of the several elements of which an average human body is composed, the bulk of the hydrogen forms one of the most striking items, and indeed, in connection with all forms of animal and vegetable life, hydrogen is of primary importance. In the argument from analogy for the existence of life in other worlds it is significant to note that an element associated in such an emphatic manner with the manifestation of life here should now be shown to be widespread through the universe.

In like manner carbon, which is, of course, an essential factor in organic substances, has been demonstrated to exist in other parts of the solar system. The most striking illustration of this fact is presented in the case of the glowing solar clouds, which there is now good reason to believe are due to carbon. Many of the comets exhibit lines in their spectra characteristic of the same element. If these bodies, as has been often supposed, are drawn by solar attraction from the remotest parts of space, the carbon which they bear testifies that this element is present through a wide extent of the universe. Here, again, modern research has gone far to strengthen the argument as to the possible existence of life elsewhere. It has shown the cosmical nature of that particular element which, if not itself the veritable abode of life, seems to be, at all events, a constituent thereof.

Illustrations of the material identity of the several globes in space might be extended. Have we not been told that a diet absolutely devoid of salt would be fatal? Now the salt, or, at all events, the sodium which forms its characteristic part, is not merely confined to the earth. The famous D line in the solar spectrum tells us that the same element abounds in the sun. Nor is this important element confined to the solar system. We have ample testimony as to the wide diffusion of sodium in stellar depths.

The iron which enters so largely into the framework of things material enters, as is well known, in no inappreciable quantity into the structure of the human body. Is there not some story of the materials for a medal of pure iron having been extracted from the mortal remains of some illustrious individual? At all events, iron in many ways, or in various combinations, is often associated with organic phenomena on the earth. It is, therefore, material to observe that this element, like others which I have mentioned, appears to be very widely distributed through space. It has been proved that many hundreds of lines in the solar spectrum must be attributed to the presence of an abundant iron atmosphere surrounding the heated solar globe. Even such distant stars as Aldebaran or Arcturus have been made to disclose the fact that iron enters into their composition in a very significant manner. If, therefore, there should not be life in the other planets, its non-existence cannot apparently be attributed to the absence of such suitable materials as life requires to build up its physical abode. So far as our knowledge goes, we feel constrained to admit that such materials are certainly present on other globes besides the earth.

At the same time, it is right to call attention to the fact that we are obliged to use great caution in any conclusion we may draw as to the space distribution of another element of much significance in the vital phenomena of this earth. I allude, of course, to oxygen. I do not indeed say that there can be any good reason to doubt that oxygen does really exist in other celestial bodies. In all probability the life-giving gas is just as abundant on many other globes as we find it to be on this one. At the same time, it is proper to remember that a widely extended distribution of oxygen has not been demonstrated in the same emphatic manner as has the existence of the other elements to which I have referred. The dearth of reliable testimony as to the cosmical distribution of oxygen may be attributed not so much to the actual absence of that element from other bodies as to the unsuitability of the means at our disposal for detecting its presence upon them. I need not go further into this point than to remark that certain well marked lines in the solar spectrum had been attributed to oxygen, and

they were no doubt correctly so attributed. It was, however, proved by Janssen that the oxygen which caused these lines, or a great part of them, did not exist in the sun, but that the lines were largely, if not wholly, due to the oxygen in the earth's atmosphere. This is not to be taken as a proof that there is no oxygen in the sun. It merely says that its presence there has not been as yet conclusively demonstrated.

This weakness in one link of the chain of evidence does not, however, seriously impair the general conclusion already mentioned, that the substratum of material necessary for life exists on other globes besides the earth. I will only add that the element calcium, which is of essential importance in the shells or the coral of the lower animals, or in the skeletons of the higher, is also one of the elements widely distributed through space.

We have thus seen that in one important respect the progress of modern research has strengthened the ancient argument from analogy in support of the belief that there is life on other worlds besides this one. It is right now to mention how, in another way, modern investigation has tended to impair that argument, or rather, I should say, to limit its application. Various lines of reasoning have rendered it almost certain that, in the matter of temperature, the several planets present considerable varieties and contrasts. I do not here refer to the temperature of the surface of the planet, which is the result of the sunbeams which fall upon it. No doubt there are individual peculiarities of each planet from this cause, the effect of which will be presently referred to. But what I am now discussing is rather the internal heat of the several globes of the system. It seems to be generally true, that the larger the dimensions of a planet, the greater is the internal heat which it still possesses. Into the reasons of this we need not now enter; suffice it to remark, that the great globe of Jupiter in this respect offers a very marked contrast to the earth. It seems to be highly probable, if indeed it be not certain, that Jupiter is at the present time heated to a temperature, at its surface, greatly in excess of the temperature of the surface of the earth. We cannot indeed assign an actual value to the temperature of Jupiter, but there seems little doubt that it must be so great as to preclude the possibility of that globe being the abode of any types of life like those which flourish on the earth. It is no doubt just conceivable that living beings of some strange and unknown fashion might endure the conditions which Jupiter appears to present; but I do not know anything which would make such a view likely. What we have said about Jupiter may, with certain modifications, apply also to Saturn, and in some degree to Uranus and to Neptune. It seems impossible that any of these great planets are at present abodes of life in any sense which is comprehensible to us.

There is reason to think that, so far as internal heat is concerned, the planet Mars, as well as Venus and Mercury, occupies much the same position as the earth.

In all four cases the internal heat may be said to be non-existent, in so far as its present effect on any manifestations of life are concerned. The superficial temperatures which these globes present, and the climates that they enjoy, must be attributed primarily to the heat received from the sun; of course, the actual effect on each globe is profoundly modified by its atmosphere, as well as by its distribution of land and water.

The four globes just named are at such varied distances from the sun that the amount of heat which they obtain will differ considerably. Mars can only get a smaller allowance of sunbeams than the earth, while Venus will receive more, and Mercury a good deal more. If we represent the average intensity of sun heat as it arrives at the earth by 100, we shall find that the intensity at Mars is no more than 43. Venus receives a share which may be represented by 191, while Mercury would get as much as 667. At the first glance it might be thought that these figures must necessarily imply vast climatic differences between the different globes. I am certainly not going to deny that this is so. Indeed, it seems to be extremely probable that there may be astonishing differences between the climatic circumstances of the planets. But what I want to insist upon at this moment is, that the condition of a planet as to climate is not merely a matter of sunbeams. A very important element consists in the extent of the atmosphere with which that planet is invested. There can be no doubt as to the presence of an atmosphere around Mars, and of another around Venus; but we have no reason to think that these atmospheres, either in density or in composition, resemble that which envelops our earth. The atmosphere around Mars, indeed, appears to be far less copious than that with which our earth is provided. This much, at least, we conclude from the transparency of the environment which permits us to study the details of Mars with far greater clearness than a Martian astronomer who was trying to survey our globe would be able to obtain through the comparatively dense medium interposed by our skies.

The character of the atmosphere of a planet will exert a marked effect upon the temperature and the climate of its globe. The abundance of that atmosphere and the proportion in which it contains watery vapor, or possibly other vapors, will all tend to modify the degree in which sun heat is admitted, and the degree in which, when admitted, it is retained. It would be quite possible for two globes enjoying equal shares of sun heat to have, nevertheless, totally unlike temperatures and climates, in consequence of atmospheric differences. We know also that the distribution of land and water has a marked effect upon climate. It was the contention of Lyell, in his famous book, that the changes of climate in the course of geological time were mainly due to alterations in the relative positions of land and water. The mention of this will, at least, remind us that climate depends upon other elements besides sun heat and atmosphere.

The significance of these considerations in connection with our present subject can hardly be overestimated. A globe may at first sight appear to be too far from the sun to enjoy sufficient light and heat to make life endurable or possible. It may nevertheless happen that by some suitably contrived atmosphere, and some special configuration of land and water, such a globe may possess regions endowed with a mild or even a genial climate. On the other hand, a globe

which was placed so close to the great source of light and heat that its inhabitants, if unprotected, would be submitted to an unendurable scorching, may yet be fitted with an atmosphere which shall render it sufficiently adapted for life, notwithstanding its apparently unpromising circumstances.

In illustration of the important climatic effects of an atmosphere, I need do little more than cite the case of the moon. Our satellite is practically at the same distance from the sun as is the earth, and in its case also, internal heat has no present effect on the temperature of its superficial portions. It would, therefore, seem that so far as sun heat is concerned, the moon must be in much the same condition as the earth. But if we thence deduced the inference that the temperature conditions prevailing on our satellite bore any resemblance to the temperature conditions prevailing on the earth, we should make a great mistake. Observations of the moon's heat show that its surface is exposed to a tremendous range of temperature, extending to hundreds of degrees.

It has been demonstrated that the temperature of the moon under the full glare of the sun rises to a point in excess of that of boiling water, while it is equally certain that when the sunbeams are withdrawn the temperature of the moon sinks to a point far below that with which any Arctic explorer has made us acquainted. Here, then, is a globe felt just as we are, with sunbeams, and yet undergoing tremendous vicissitudes of climate entirely surpassing any changes endured by the earth. The climatic difference between these two neighboring globes is certainly connected with the fact that the moon has very little atmosphere, even if it be not completely destitute thereof. Our atmosphere acts as a climatic regulator. It reduces the degree in which the intense fervor of the sun affects the earth, and it mitigates the rigor of the cold to which the earth would be exposed when the sunbeams are withdrawn. Such an ameliorating agent is absent from the moon, and hence arise those violent extremes of its climatic condition. We thus see what potent factors the existence and the extent of an atmosphere become, in determining the nature of the climate that a planet is to have. We do not know enough regarding the atmospheres of Mars, Venus, and Mercury to be able to draw any certain conclusions with regard to their climates. But this much we may at least affirm, that it seems quite possible for the different influences we have named to go a long way toward neutralizing the contrasts which the climates of these globes would otherwise present in consequence of the different supplies of sunbeams that they receive at their actual solar distances. So far as mere climate is concerned, it seems quite possible that appropriate atmospheres and land distributions might be adjusted on the earth and Mars, Mercury and Venus in such a manner that certain organic types might be common to all the four globes.

Of course, the presence or absence of water on a potential world must be a very material element in deciding as to whether life can exist thereon. The absence of water from the moon, for instance, must be at once admitted to be incompatible with the existence of life on that globe, in so far, at least, as the world life conveys to us any intelligible meaning. But though there is no water to be discerned at present on our satellite, yet it would seem highly probable that other globes may not be similarly destitute. One of the most striking features which Mars presents when that planet is placed in a favorable opposition consists in its wonderful Arctic region of white material. This seems to grow as the winter advances on Mars, and decreases when summer reigns on that hemisphere of the planet which is exposed to us. Now we should certainly be going beyond the actual extent of our knowledge were we to affirm that what we see on Mars is certainly ice or snow, similar to that which we find in our own Arctic regions. It seems, however, hardly possible for us to frame any other supposition which could be reconciled with the facts. Indeed, the whole appearance of the planet makes it highly probable that water is quite as important a factor in the constitution of that globe as it is in our own.

Venus is so circumstanced in regard to the position which it has, relatively to the earth, that we are not able to examine it with the same degree of success as that which attends the study of our neighboring planet on the other side. It would appear, however, from the observations of Trouvelot, that the poles of this planet are also characterized by caps of white material, which remind us of the polar condition of our own earth, as well as of Mars. We do not see Mercury sufficiently well to form any conclusion as to whether it may possess similar features. The clouds of Jupiter doubtless also contain water, even if they are not entirely composed thereof, though for the reasons already assigned, it seems quite unlikely that there can be any life on that globe.

In the absence of any definite knowledge as to the composition of the atmospheres by which the planets are surrounded, or as to the climates which they enjoy, it would certainly be idle for us to speculate as to how far they might possibly be tenanted by creatures resembling those found on this earth. It would also be impossible for us to form any conception as to the biological characteristics of creatures which would be adapted for residence on the several planets. There is, however, one merely mechanical matter which may be usefully mentioned, inasmuch as it depends on considerations which admit of demonstration.

We are able to weigh the several planets. Indeed, the problem is a comparatively easy one, when applied to those bodies which are attended by satellites, inasmuch as the movements of the satellites contain indications of the weights of their primaries. But even when a planet has no satellites, it is still possible for an astronomer to find the weight of a body by the effect which its attraction produces on other planets. But the weight of a planet must stand in important relation to the framework of the organisms which are adapted to dwell upon it. Let me try to make this clear by a few illustrations.

Suppose that a planet, while still retaining the same size, was to be greatly increased as to its mass. The consequences would be felt very seriously by all organized creatures. The most immediate effect would be to increase the apparent weight of everything. If, for instance, a globe the same size as the earth possessed double the mass of the earth, the effect would be that

the weight of each animal on the heavier globe would be double that on the earth. A horse placed on the heavy globe would be subjected to a load which would oppress him as greatly as if while standing on our earth, as at present constituted, he bore a weight of lead on his back which amounted to as many stones as the animal itself. Each leg of an elephant would be called upon to sustain just double the not inconsiderable thrust which at present such a pillar has to bear. A bird which soars here with ease and grace would find that the difficulty of such movements was greatly increased, even if they were not wholly impossible, on a globe of equal size to the earth, but double weight. It would seem as if flying animals must be the denizens of light globes, rather than of heavy ones.

It is also easy to show that in general, other things being equal, the size of an animal should tend to vary in an inverse direction to that of the mass of the globe on which it dwells. At first it might be supposed that big animals might be most appropriately located on big worlds, and small animals on small worlds. No doubt there are so many circumstances to be considered, of which we are in almost complete ignorance, that any statements of this kind must be received with considerable caution. We may, however, assert with some confidence that, so far as our knowledge goes, the truth lies the other way. It is the small animals which are adapted for the larger worlds; it is the big animals which are adapted for the smaller worlds. The proof of this involves an interesting point.

The argument is as follows: Suppose that an animal on this earth, as it is at present, were to have every dimension doubled. To take a particular instance, conceive the existence of a giant horse which was twice as high, and twice as long, in every feature and detail, as an ordinary horse. It is obvious that all three dimensions of the animal are doubled, its volume and therefore its weight would be increased eightfold, and the weight that would have to be transmitted down each of the four legs would be increased eightfold. Each leg of the giant horse would, therefore, have to possess eight times the weight-sustaining power that would suffice for the leg of the ordinary horse. As the proportions are supposed to have been observed throughout, the leg of the giant horse would be of course considerably stronger than that of the ordinary horse, but it would not be so much stronger as to enable it to accomplish the task it would be called on to perform. The section of the leg of the giant horse would no doubt be double in diameter that of the normal individual. This would imply that the area of the section was increased fourfold. But we have seen that the weight transmitted was increased eightfold. Study the effect of this on the horse's hoof in contact with the ground. In the giant horse the area of the surface of contact would be four times as great as in the normal horse. As, however, the weight transmitted is eight times as great, it follows that this wear and tear on each square inch of the foot, and this is the proper way to estimate it, would be just twice as destructive in the giant horse as it would be in the ordinary animal. If then, as we may well suppose, the foot of the latter is just adapted for the work which it has to do, then the foot of the giant horse would be incapable of withstanding the wear and tear to which it would be subjected. It follows that an effective animal, on the scale we have suggested, would be an impossibility on our earth; at all events, when the materials from which it was made were the same as those out of which our animals are fashioned.

Suppose this giant horse, instead of being left on this earth, were transferred to another globe, which only exerted half the gravitating effect experienced on the earth's surface, then the effort the animal would have to make in supporting its own weight would only be half that which it has to put forth here. The consequence is, that the framework of the giant horse would in such a case have to support a weight which was not more than four times that of an ordinary horse standing on the earth. As the area of the bases of support in the large animal was fourfold that in the normal horse, it would follow that, area for area, there would be a pressure transmitted through the foot of the giant horse on the less ponderous globe precisely equal to that of the normal horse on the earth. The materials of which the big horse is built ought, therefore, to be able to sustain him effectively when he was placed on the light globe. It, therefore, appears that, so far as gravitation is concerned, the big horse would be better adapted for the light globe and the small horse for the heavy one. More generally, we may assert that, regarding only the point of view at present before us, the limbs of smaller animals would be better adapted for vigorous movement on great planets than would those of large creatures.

It is, however, proper to bear in mind the point to which attention was, so far as I know, first called by Mr. Herbert Spencer. He has shown that there are excellent biological reasons, quite independent of those mechanical considerations to which I have referred, why it would be impossible for an efficient animal to be constructed by simply doubling every dimension of an existing animal. The support of the creature's life has to be effected by the absorption of nourishment through various surfaces in the body. But if all the dimensions are doubled, the bodily volume, as we have already mentioned, is increased eightfold, and therefore its sustenance would, generally speaking, require eight times the supply that sufficed for the original animal. On the other hand, supposing the same scale to be observed throughout the animal's body, the available surface area for absorption of nourishment has only increased fourfold, and therefore each square inch would have to do double duty in the large animal. If, however, the surfaces are at present at full work, it would seem impossible that they should efficiently undertake double the work they now get through. On this account, therefore, a live animal would seem impossible on a simple specification of dimensions twice those of any existing animal. Great structural modifications of pattern would have to accompany the enlargement of bulk. This, be it observed, is wholly independent of all questions as to gravitation.

No reasonable person will, I think, doubt that the tendency of modern research has been in favor of the supposition that there may be life on some of the other globes. But the character of each organism has

to be fitted so exactly to its environment, that it seems in the highest degree unlikely that any organism we know here could live on any other globe elsewhere. We cannot conjecture what the organism must be which would be adapted for a residence in Venus or Mars, nor does any line of research at present known to us hold out the hope of more definite knowledge.—Fortnightly Review.

IMAGINATION IN GARDENING.

THERE is no doubt that in our day landscape gardening is occasionally carried to a greater degree of perfection than ever before. The great park systems of some of our cities are without rivals in the Old World, and there are private grounds here where true artistic feeling in composition is expressed by most exquisite arrangements, and a truly artistic sense of the requirements of the situation. But there is a question whether most of the private gardens nowadays are constructed with the same sense of the picturesque which used to make English gardens nowadays the expression of their owners' individuality. Those gardens were, and, no doubt, often still are, whimsical, but they meant something; and even their mistakes showed a healthy sort of interest in the subject, and in the disposition of their treasures there was a care beyond what is mechanical and perfunctory, and something better than a mere imitation of their neighbors.

Italian gardens, with all their formality, still retain that imaginative charm. There is an expression of stateliness, of mystery, of classic grace, about them that makes the forlornest of them interesting to this day. The mossy fountains crumbling to decay, the rows of feathery cypresses, the cool thickets of ilex, in which the nightingales sing even at noonday, the resting places from which are glimpses of scenery, all suggest the planning of those pleasure grounds by and for those who were true lovers of nature, and to whom the garden was a frequent resort and a continuous joy. The same is true of French gardens, where the imagination is governed by the restraints of that Gallic taste which pervades most things of a decorative kind constructed by that keenly perceptive people. Even the Dutch gardens are expressive, if not of the imagination of the Netherlands, at least of their most marked characteristics—orderliness, practicality, straightforwardness and simplicity.

In England there may be a want of taste, but never a lack of imagination, and here we have constant evidence of the delight taken by men of eminence in statecraft and letters in the construction of ingenious gardens, which were intended at least to express their owners' ideas of the picturesque. Queer enough some of those ideas may have been, and, where the wealth of the proprietor permitted, imagination too often ran riot and admitted monstrosities into the scheme; but at bottom, the idea that a garden should be an individual expression, even of an owner's whim, was not a bad one, since through reckless experiment one sometimes arrives at a great truth. Certainly it was a thousand times more hopeful a symptom than the senseless repetition and imitation from which one suffers in many would-be magnificent places in our own country. In the grotesque conceptions of the eighteenth century there was at least a struggling idea, while in the monotonous and constantly recurring arrangements which we too often see now, no idea whatever enters, except to be conventional.

It is possible that the lack of a leisure class in this country may account for a good deal of this monotony in our large places. Still there are more men here than one would suspect who care something about gardens, and who are willing to give them some time and attention. But this interest rarely becomes strong enough to excite any original thinking, and comparatively few men have any conception that there is such a thing as a possible picture in every plot of ground, with a definite meaning in the mind of its creator. In Europe there is a certain traditional art in planting which has descended through succeeding ages, and some of this came to these shores with our forefathers, so that the early gardens of America bore its impressions more than do those of the present day, which for the most part are mere collections of more or less curious and beautiful plants. It was the element of fancy which made the old gardens beautiful and dear, so that to this day they retain their charm, even if their fashion has passed away. They exhale the aroma of the imagination which created them and so retain a perennial hold upon us. Even the grotesques and the statues which we now condemn seem no more out of place in an eighteenth century garden than the quaintnesses in the literary style of the epoch. The essential thing is to have some ideal and some mode of expressing it, a style which is our own and not that of our fathers or grandfathers—and above all, not that of our neighbors. When we once have a style, the perfecting of it is but a matter of time and study and adaptation to our changing circumstances.

The genius of Lord Bacon did not disdain to concern itself with the reformation of national taste in England in the matter of gardens, and he wisely suggested winter or evergreen gardens, and the preservation of rude and neglected spots as specimens of wild nature, and though in his day that suggestion did not bear much fruit, it, no doubt, opened the minds of his readers to new light upon this important topic; so that when in the reign of Charles the Second the genius of Le Notre began to make itself felt in France, there were thinking men in England ready to comprehend his rare ability, and the king himself summoned him to lay out Greenwich and St. James's Parks. Charles also added the semicircle to Wolsey's Hampton Court, so stately to this day with its broad terraces and fountains and gay parterres of flowers; and in his reign the gentle Evelyn gave a tremendous impulse to picturesque gardening by his own work and by his appreciation of what was being done by kindred spirits about him. "Two mummies and a grot," which he found at Bushnell's Wells, at Enstone, scarcely correspond to modern ideas of garden decoration, but here the proprietor "lay in a hammock like an Indian," and doubtless allowed his imagination free rein.

Then, with the arrival of the Dutch king, came the gates and rails of wrought iron and the clipped yews and vegetable sculpture of the period. Sir William Temple's idea of a perfect garden was a flat or gentle

desirability of an oblong shape lying in front of the house, with a descent of steps from a terrace extending the whole length of the house, this inclosure cultivated as a kitchen garden and orchard; but this idea was viewed with contempt by such an enlightened observer as Lord Walpole, and soon the vegetables gave place to lawn and trees. Queen Caroline gave a still further impulse to the natural style, and winding waters were introduced into the scheme of Kensington Gardens. Pope and Addison ridiculed the formalities and clippings of their day, and little by little the emancipation of taste in England grew general. Pictures were studied by some to gain an idea of suitable composition; shrubberies were introduced, with winding walks along their borders; points of view were developed; some even went so far as to make their scenes emblematical of pastoral poetry, and even sentimental fairs were attempted. Shenstone is said to have ruined himself in gardening at Leasowes, and broke his heart over his disappointments, and the echo of his taste is caught in his verse. Then came Kent, the landscape artist, who planned "Elysian scenes," shading in his more finished pieces with evergreens, and his successor, Wright, whose ideas were afterward developed by Beekford at Fonthill Abbey. Such was the craving for the improvement of grounds in England in the eighteenth century that there were not artists enough to direct the movement. It was by the exercise of imagination that English landscape gardening progressed, now advancing and now retrograding, until it has come to stand as a synonym for what is picturesque and individual.

In our own country, young as it still is, there are splendid flashes of inspiration in this direction, which give promise of a time when our gardens will be in some adequate way an expression of the genius of the republic. Great object lessons, like Central Park, the Boston Metropolitan Park system, the Columbian Exposition, and other realizations of a poet's dream, cannot fail to leave their effect upon a community. All great work in any art prompts individuals to original thought, and we need to give more rein to fancy in our own home arrangements, to think out for ourselves some scheme to be developed at leisure, and to profit by all such help as is offered by triumphs of landscape art or the example of Nature in her most favorable moments.

It is far easier to fall into the mechanical than to rise to the imaginative style, and yet the latter, once attained, appeals so directly, even to the uneducated eye, that it proves its right to a place among the fine arts. The same laws which govern composition of all kinds here are paramount and are equally imperative in literature, in painting and in landscape effects. Simplicity, purpose, restraint, economy of means, are the guiding principles of great art, wherever it is to be found. If there is nothing in what is done, it soon grows wearisome. The commanding quality of the human mind is high imagination; this alone is not outworn by ephemeral fashions, and a great park which is born of such an inspiration will never cease to make appeal to our nobler faculties, and even a modest garden, if it expresses the best thought of its creator, will have refining influence upon all who come under its spell.

Hingham, Mass. M.C.R., in Garden and Forest.

FOSSILIZED BIG TREES, CALIFORNIA.

By Prof. A. LAKES.

THE California big trees, or *Sequoia gigantea*, so familiar to the dwellers on the Pacific slope and so celebrated throughout the world, have an interesting geological history and pedigree. Not only are they, perhaps, the oldest trees now living in the world, but they date from quite an early geological time. They were among the first genuine trees, like those of the modern age, to appear on this planet, for we cannot consider as trees proper the gigantic and fantastic reeds and mosses which preceded them in the old Devonian and Carboniferous times. Those were rather gigantic plants than true trees, despite their great height and thickness.

The Sequoias made their first appearance in that middle portion of the world's existence known as the Mesozoic or Middle Life era, and in that subdivision of it called the Cretaceous—an age teeming both on sea and land with strange reptilian life. The fossil remains of these trees are found scattered over the northern hemisphere, even in the rocks beneath the eternal snows of Spitzbergen, Melville Island and Greenland. They are found also in the same class of rocks in Canada, Saxony, Bohemia and Belgium. In the rocks of the succeeding Tertiary or Mammalian age they are found fossilized all over the world—in Greenland, Spitzbergen, Alaska, Sitka, Colorado, the Hebrides, and down through Asia to Italy.

Though there are but two varieties of these trees now living, and those confined to the Pacific coast, in those olden times there were as many as twenty-six varieties, extending over the northern hemisphere from latitude 43° to 78°, and even as far south as in the Tertiary rocks of Australia. Truly, these most ancient of living trees are monuments of the great past, "survivals of the fittest" living on into the living present, and as we stand in awe before their colossal forms we may say

This was the forest primeval.

The great Reptilian age began with dreary forests of reeds and these tall pines, probably but little frequented by the great lizards, which forsook these dismal shades for the warmer swamps and beaches of the sunny coast.

With the Tertiary there is a sudden influx of trees like those of to-day, coming on like a sudden creation without any marked intermediate forms from which they could have gradually evolved. Throughout the Rocky Mountains we find abundance of the fossil remains of such trees, many of them of a semi-tropical character, such as the sweet gum, persimmon, tulip tree, magnolia and others, some of which are common in California gardens to-day. With these were such common temperate zone trees as the chestnut, birch, maple, poplar, etc. Nor were such trees limited as now to the modern temperate or semi-tropical trees, for we find their fossil remains embedded in the rocks below the snows of Greenland and in Vancouver Island. The tulip tree, for example, is often found in the rocks of the Arctic circle.

The causes of the change of climate which brought about these changes in the habitat of this vegetation is too abstract a matter to describe here. It seems as if the march of vegetation and tree life had been from the north and Arctic zone toward the south, and as if a semi-tropical Garden of Eden had existed in the region of now perpetual snow and ice.

The rocks of Colorado of the upper Cretaceous and Tertiary periods are full of fossil wood and fossil leaves, and by the erosion of these beds we find quantities of fragments of fossil wood scattered over the prairie among the surface drift. These fossil woods doubtless belonged to the trees we have mentioned, such as oak, poplar, hickory and palmetto. Not unfrequently we find their stumps standing erect in the strata in the position in which they originally grew.

During the past summer, on my way from the gold mining region of Cripple Creek, I stopped at Horrisant Station, a locality noted for its fossil trees, as well as fossil insects, leaves and fishes, embedded in its shales.

Here, right in the heart of the granite hills, we have the relics of a small Tertiary lake represented by horizontal beds of shale and sandstone, abutting against and skirting the flanks of granite hills, which must have formed islands in the lake, or traceable up many little valleys which may have formed creeks and bays.

Around the skirts of one of these ancient granite islets, embedded in the shale which is composed of fine volcanic material, are a number of gigantic fossil stumps—a few years ago, doubtless, rising a foot or so above the level of the meadow, but by the work of tourists and the elements now for the most part leveled with the soil.

These stumps, whose diameters vary from six to fifteen feet, have the wood so wonderfully and minutely replaced by stony matter that, were it not for their great size and that on taking up a chip you feel its hardness and weight, one might pass them by as stumps of old pine trees cut down by the ax of the settler of a few years ago. The prevailing color of the wood is an ashen gray like a dry chip, but sometimes the infiltration of a little iron has almost restored the original reddish color. Not only is the wood and bark microscopically and molecularly replaced by stone, but even the minutest as well as the larger sap veins are replaced by translucent chalcedony and opal, simulating fossil gum.

One of the largest of these stumps has been unearthed down to the upper portion of its roots by some parties who contemplated sawing it up in vertical lengths and transporting it bodily to the World's Fair. But, despite their improvised machinery and stone saws, they, happily for Colorado, signally failed. They found the hard silica of the tree too hard for their stone saws, and the latter are seen still sticking in the stump as monuments of their vandalism and failure. By the grain and general appearance of the wood, despite its being turned to stone, a Californian would at once recognize it as his native redwood—a presumption which is proved by microscopic examination of fine sections of it as compared with the living redwood. The diameter of this tree, as it stands about twelve feet above the bottom of the quarry, is fifteen feet. In the fine-grained, paper-like shales inclosing the tree we found numerous remains of fossil insects, such as ants, grasshoppers, lantern flies, beetles, etc., and some years ago Prof. Seudder discovered a perfect butterfly, the impression so exquisitely preserved that even the pattern of the colors on the wings was easily recognized. Only one or two specimens of fossil butterflies besides this have been discovered in the world. The remains of a sparrow and fresh water fishes and shells have also been found in the same beds.

The history of the lake and its fossil remains seems to be as follows: There was in Tertiary times a lake among these granite hills, by the side of which grew these sequoias, together with many other kinds of trees, as shown by the varieties of leaves found. Fishes inhabited its waters and insects flitted over its surface or basked on the wet mud at low water, as butterflies are often seen to do nowadays by the mud of a stream. Winds blew leaves out onto the surface, which sunk to the bottom and became embedded in the mud. Insects in various ways found a grave in its waters and a burying place in its muddy bottom, and the great sequoias growing on the banks died of old age or by the rotting of their roots from the encroaching waters, and their stumps were entombed with the other remains.

On the shores of this lake—perhaps like at Lake Mono in California—were a number of volcanic vents, which, in their periodic explosive eruptions, threw up clouds of volcanic dust and ashes, which fell back in showers into the lake and contributed the material that entombed the fossil life. Gases from these eruptions may have assisted in destroying insects and birds flying over the surface of the lake. All the shales and sandstones inclosing these remains are made of comminuted volcanic matter, sometimes exceedingly fine, as of volcanic dust, sometimes coarser. We noticed on one of the hills above the petrified stumps evidences of former hot spring or geyser action, which usually accompany the last dying efforts of volcanic action. This appears to have been as in the neighboring Cripple Creek mining region—the last phase of volcanic activity such heated waters may have assisted in dissolving silver and petrifying the stumps. The lake eventually either filled up with volcanic mud or dried up, or was drained off. Erosion wore out valleys and parks in the soft shale, exposed the buried and fossilized tree trunks, and enabled us to explore the fossil fauna and flora of the locality as to the mode of fossilizing, or the petrifying process, which is often a subject of wonder. In the case of the tree stumps, after they became embedded in the mud, they were hermetically sealed from the air, and so immediate decomposition was for a time prevented.

The trees became thoroughly saturated or "water-logged," and with the moisture came in silicious or quartzose matter permeating every cell and fiber; and, as the woody matter of the cells passed gradually away, its place was supplied, molecule for molecule, by this mineral matter till the whole tree was replaced by stone. The insects and leaves have not been so replaced by stone; only their impressions remain in the fine mud, much as the patterns of leaves are sometimes prettily made on the cement of the sidewalks of Alameda and San Francisco.—Min. and Sci. Press.

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TABLE OF CONTENTS.

	PAGE
I. AERONAUTICS.—A Guidable Parachute.—A suggestion for balloons in descending.—1 illustration.	15852
Experiments in Aeronautics.—By HIRSH'S MAXIM.—Conclusion of this contribution from the inventor of the flying machine, with discussion.	15856
II. ASTRONOMY.—The Possibility of Life in Other Worlds.—By Sir ROBERT BALL.—A most graphic presentation of this subject by the great astronomer.—Bases for reaching a conclusion.	15859
III. BUILDING.—Cart and Load Lifted.—A new system in the erection of tall buildings.—1 illustration.	15857
IV. CHEMISTRY.—Atomic Volumes.—By C. T. BLANCHARD, M.A.—An exhaustive table of atomic factors based on different authorities.	15858
V. DRAWING.—A New Drawing Apparatus.—An appliance for artists to use in copying.—4 illustrations.	15860
VI. ELECTRICITY.—Portable Accumulators.—A secondary battery of light weight and small dimensions.—1 illustration.	15861
Electricity on Board Ship.—By ALFRED H. GIBBINGS.—A valuable paper read before an English society.	15867
Holophane Globes.—An improvement in electric street lighting by the use of ribbed glass.—2 illustrations.	15869
VII. GEOLOGY.—Fossilized Big Trees California.—By Prof. A. LAKES.—The famous petrified wood of the Western State and its geological history.	15863
VIII. HOROLOGY.—Manufacture of Cheap Watches.—The Waterbury watch.—Its construction and making described.—1 illustration.	15849
IX. HORTICULTURE.—Imagination in Gardening.—The work of the landscape architect and gardener.	15861
X. MECHANICAL ENGINEERING.—The Measurement of Power Brakes and Dynamometers.—By G. D. HISCOX, M.E.—A practical article on this important engineering topic.—1 illustration.	15863
Practical Measurement of the Velocity of the Wind.—1 illustration.	15864
The Thelwell Moist Air Condenser.—An effective and economical surface condenser.—1 illustration.	15865
XI. MEDICAL.—A New Apparatus for Administering Anesthetics.—An apparatus for forcing the vapor by a tube into the larynx.—1 illustration.	15869
XII. METALLURGY.—Treatment of Auriferous Ores with Bromine.—The extraction of gold as bromide from roasted ores.	15866
XIII. NAVAL ENGINEERING.—An Improved Sail Rig for Vessels.—A simple and effective suggestion from a seaman.—1 illustration.	15866
XIV. MISCELLANEOUS.—Moscow.—The great city of Russia described.—1 illustration.	15847
Railroad Precautions in Russia.—Guarding the funeral train of the Czar.—1 illustration.	15847
Railway Mileage of the World.—Graphic representation of this figure.—1 illustration.	15848
XV. PHOTOGRAPHY.—Improved Flat Image Lenses.—A new type of objective for photographic cameras.—1 illustration.	15856
XVI. TECHNOLOGY.—The Yarran Evaporator for the Distillation of Sea Water upon Sand.—A multiple effect evaporator.—A Red Sea installation described.—1 illustration.	15851
Ball Bearing Axles and Rubber Tires.—Aids to the locomotion of vehicles considered from the carriage builders' standpoint.—Interesting historical notes and technical points.	15848

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